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GERB Operations Report

James Rufus

GIST 36 – ECMWF, 18th Oct 2016

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Introduction

GERB-3

- Recap recovery from stuck despin mirror
- Summarise effect of ~21 month outage on mirror face
- DSM performance since recovery

GERB-4

- Commissioning including early spin rate problems
- In orbit storage activation operations

GERB-1

- Despin mirror bearing end of life

GERB-2

- Move to 41.5ºE
- Limited drift data and issues with ESU/SOL

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GERB-3 Recovery Overview

GERB-3 Test 22 involved three distinct sections:

- Power Cycling

  In order to try to find a more favourable starting position a power cycle was necessary. The first significant position change was generated by a power cycle on 21/01/15 but the position this position (202.46º) was worse than before (36.8º)

- Position Testing

  With the despin drive disabled coarse phase commands were used to isolate which of the 50 sectors the uninitialized pitch counter was reading.

- Enabling Patch 308

  The patch to cycle despin torque by switching direction (Iq) every 16 packets and Id between off and maximum every 4 packets.

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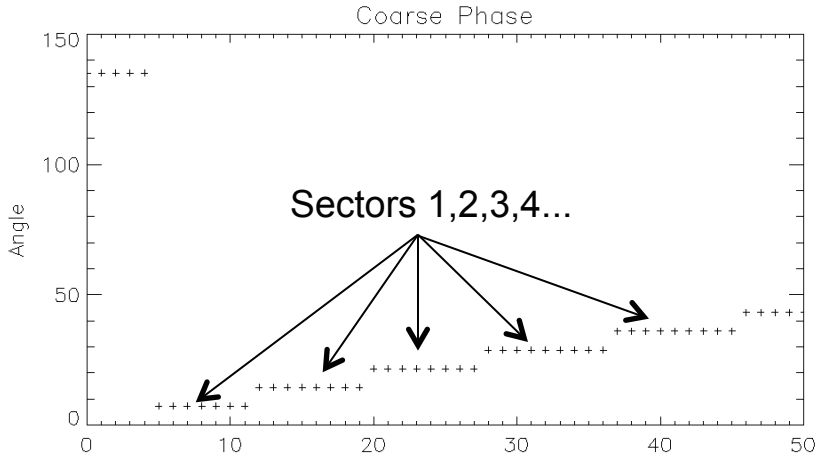
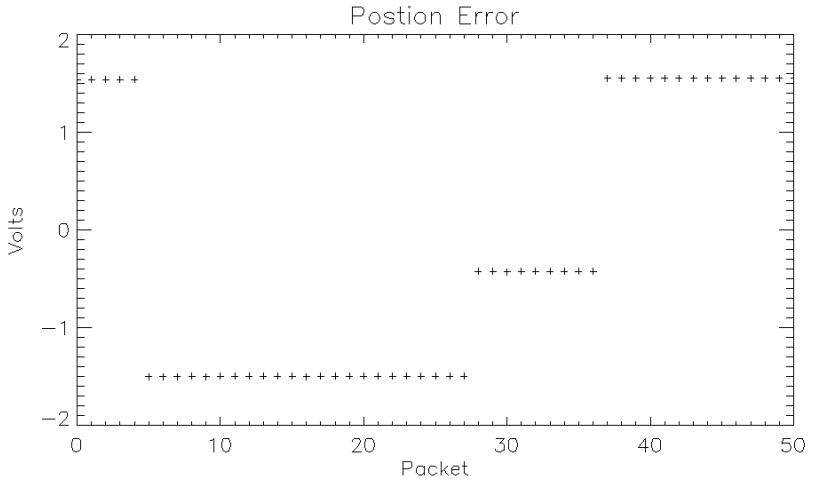
The Control System Position Testing

A coarse phase sweep gives the most significant bits in the control system mirror position. Sweeping at 7.2º intervals gives the finds the smallest position error for sector 4 and gives a new position of 29.66º.

Michael Tombs' model shows that sector 4 should produce a much greater torque in the reverse direction than we have exerted before.



Pitch Counter n (x 7.2)	Apparent Control System Pos.	Last known Motor Position	Effective field angle error	Max Torque T Id = 0	Iq = -1 Id = 0.5	Iq = +1 Id = 0.5
2	15.3	15.3	0.0	100%	-100%	100%
4	**29.7**	**15.3**	**158.4**	**-93%**	**75%**	**-111%**
5	36.9	15.3	237.6	-54%	96%	-11%
28	202.5	15.3	259.2	-19%	68%	30%



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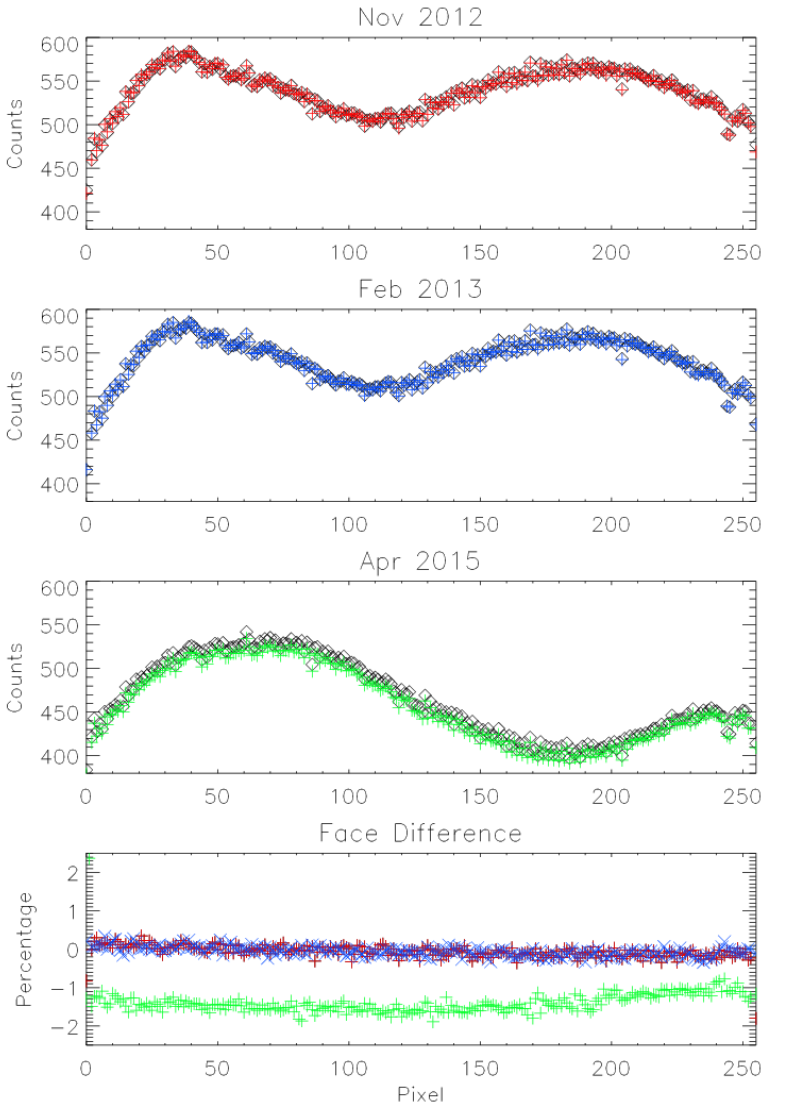
GERB-3 Mirror Face Comparison

The CALMON scans produce 750 illuminated GERB columns across a slowly varying source at 0.7 arcmin and ~0.6s separation.

Comparing the mean pixel response for each mirror side we see that the ratio is stable in early operations but there is a small offset after the jam period.

The mirror face responses to the CALMON signal have changed by 1.4±0.2% over the two years relative to each other.

For GERB-4 IOS the DSM park angle has been updated to 67°



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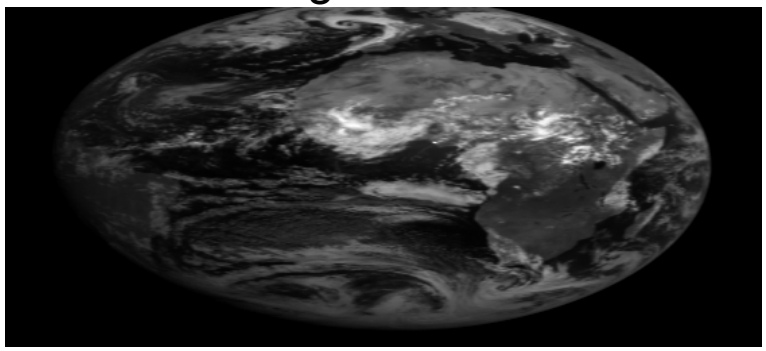
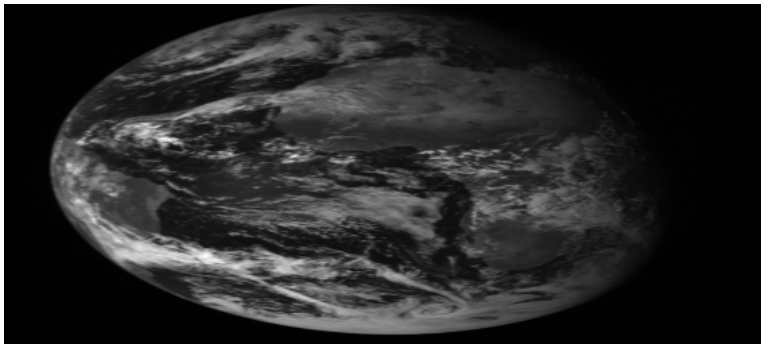
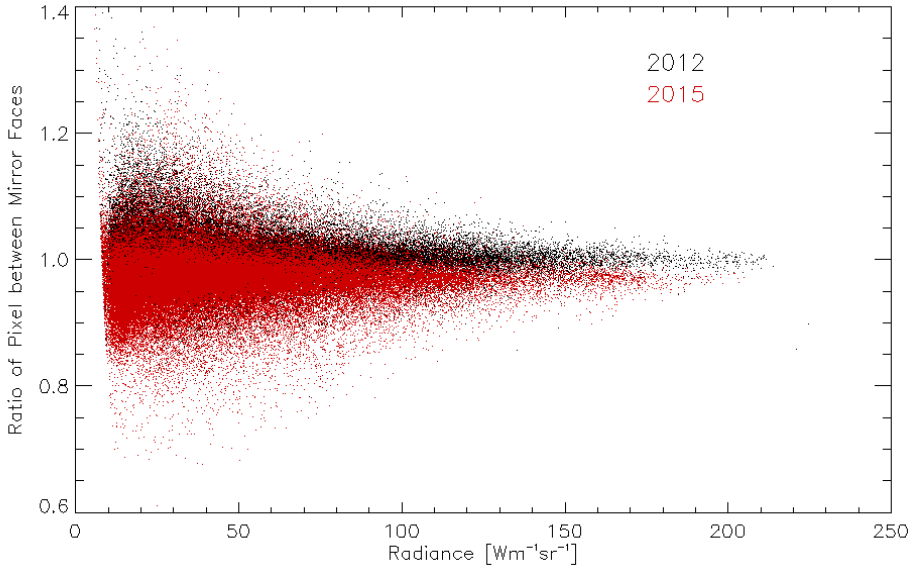
GERB-3 Earthview Mirror Face Comparison

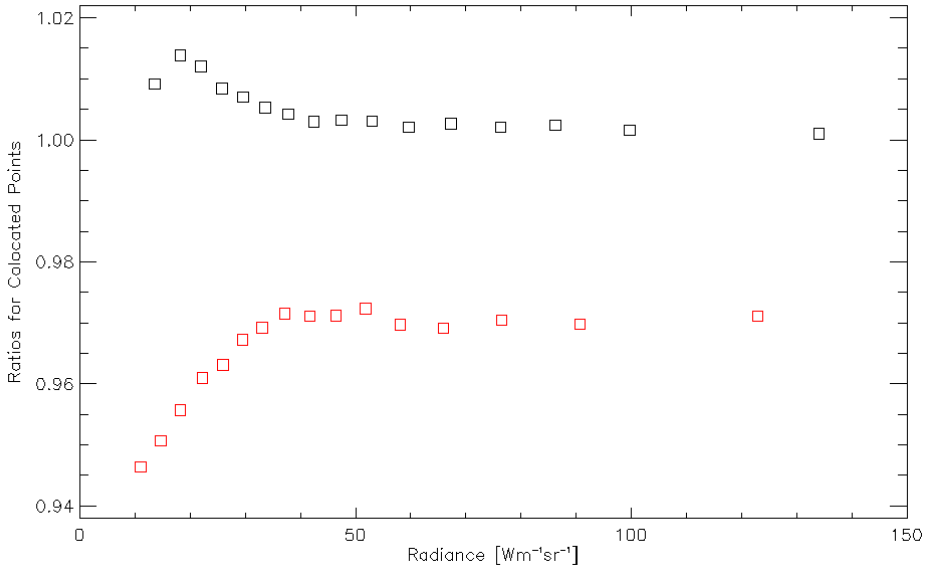
August 2012



November 2015







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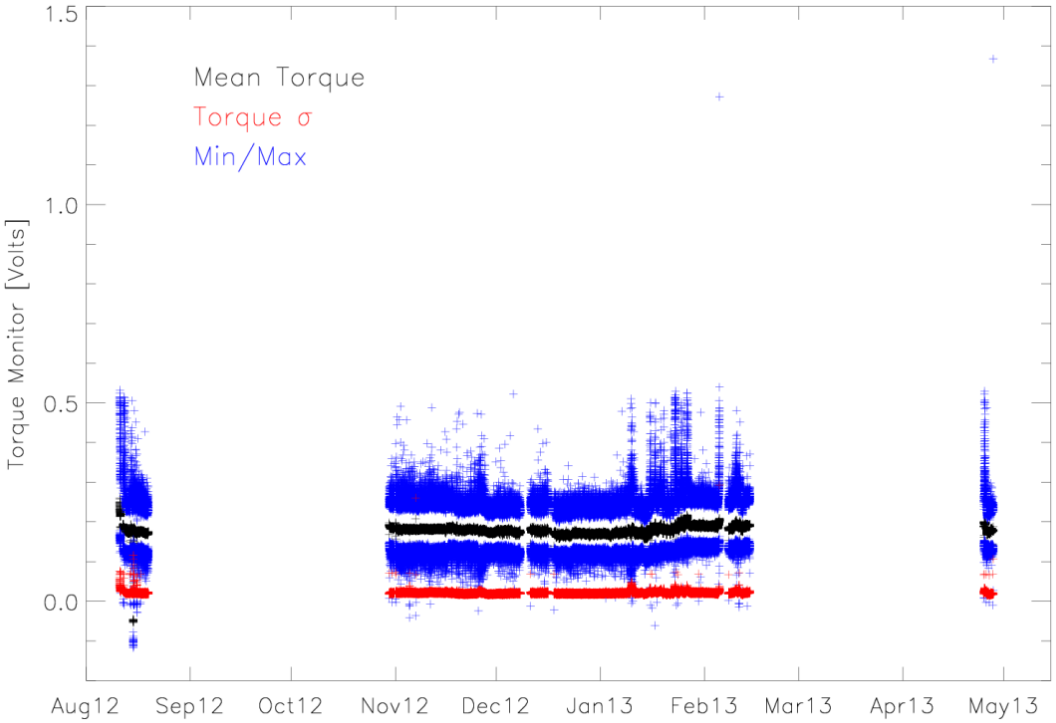
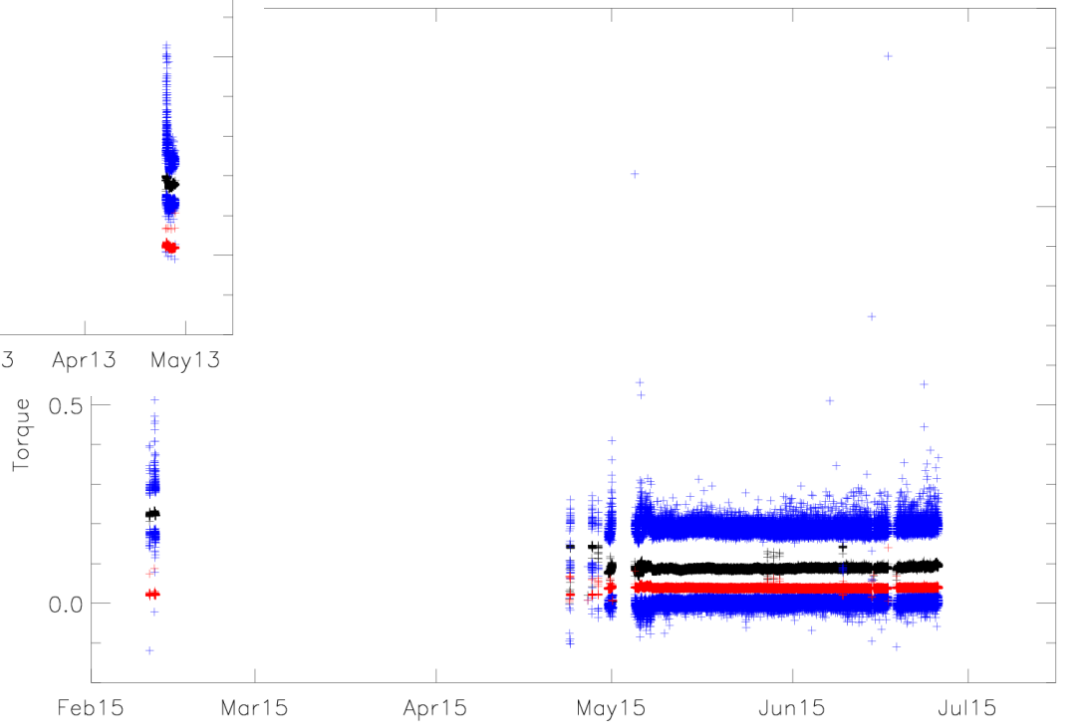
GERB-3 Drive Torque Pre/Post Jamming Event





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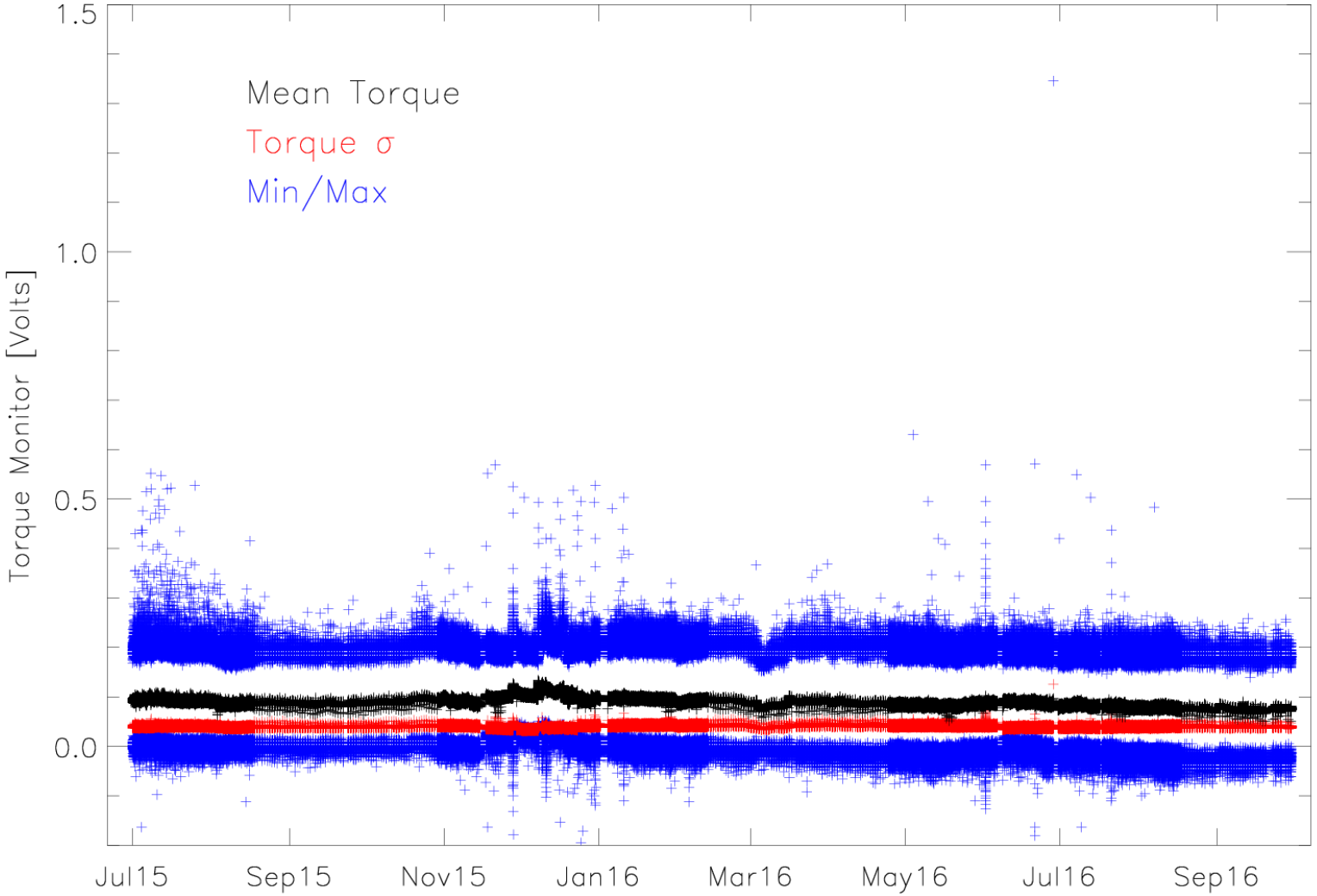
GERB-3 Torque Monitor



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GERB-3 Mirror Incidents since Restart

On GERB-3 AutoSUNBLOCK (Patch 302) and AutoDisable (Patch 310) are always active allowing the DSM to respond quickly to events and avoid driving with maximum torque for long periods. Patch 302 also gives a burst of high resolution mirror telemetry up to the point the limits are violated.

There have been thirteen mirror mispointing events since the restart.

1st May 2015	**Both patches tripped**
15th June	Just Patch 302
17th June	**Both patches tripped, failed routine start up**
1st July	Just Patch 302
20th November	Just Patch 302
28th November	Just Patch 302
23rd December	Just Patch 302
26th December	Just Patch 302
30th December	Just Patch 302
28th May 2016	Just Patch 302
28th June	**Both patches tripped, failed routine start up**
16th July	Just Patch 302
20th July	Just Patch 302

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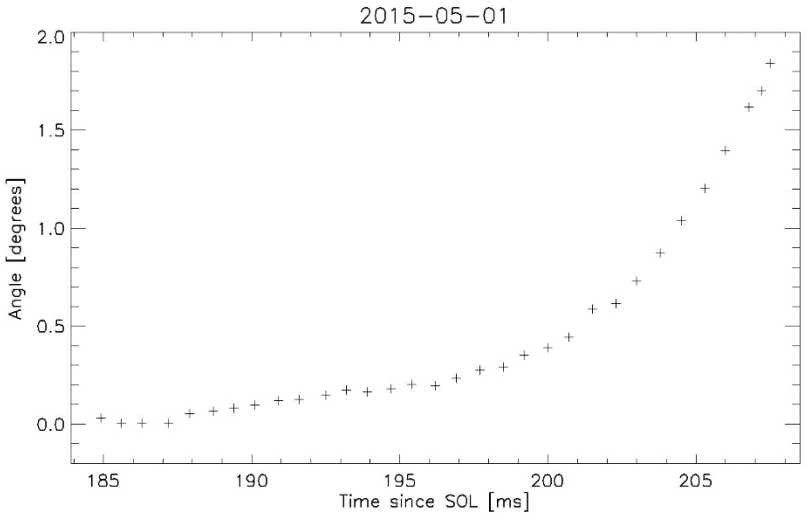
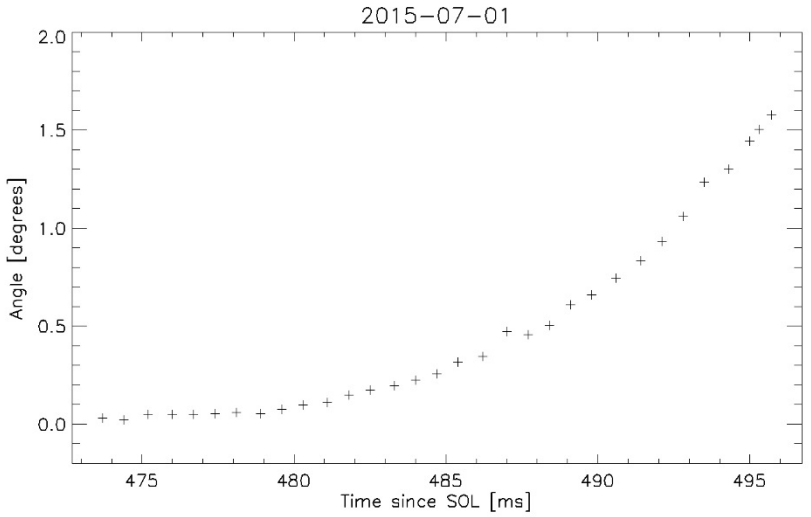
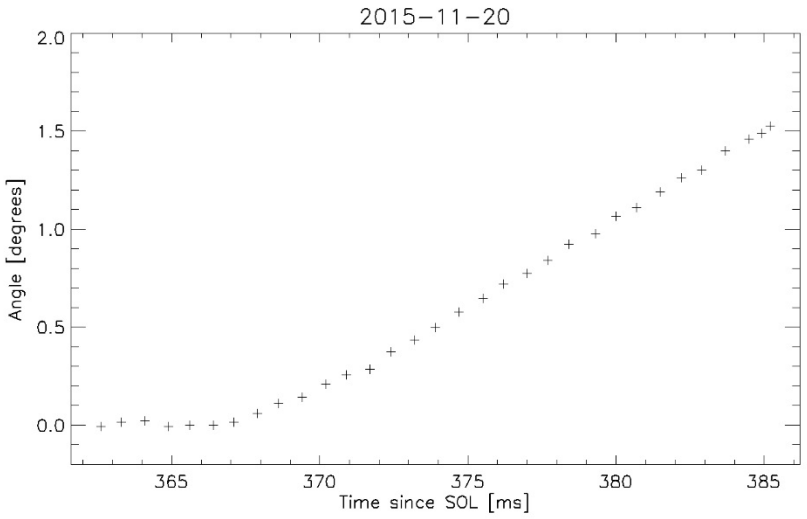
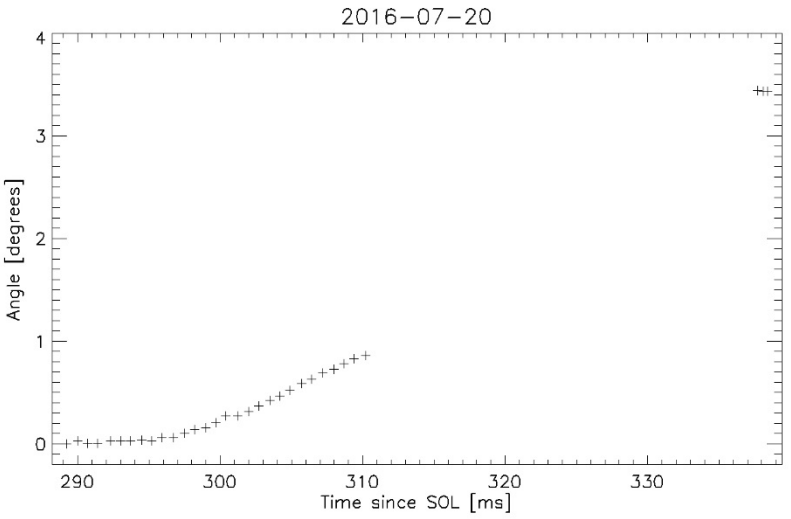
GERB-3 Patch 302 Telemetry from DSM Incidents









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Restart – 17th June 2015

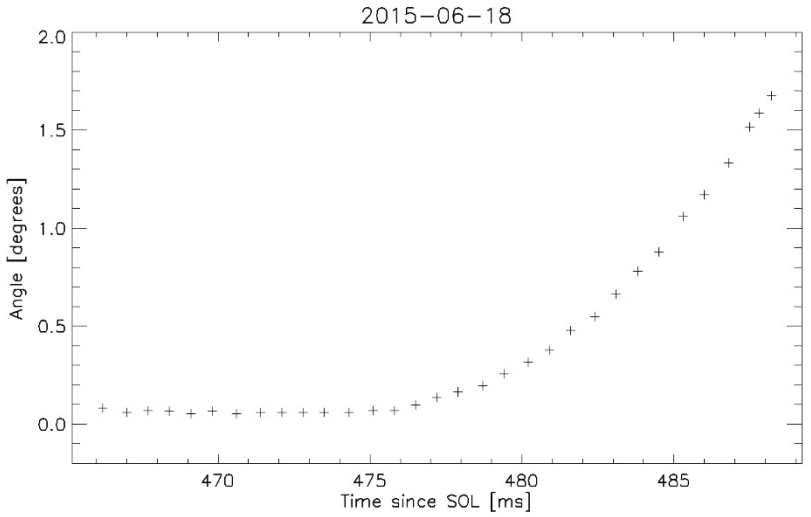
GERB-3 DSM returns to home position (0º) on re-enabling the drive.

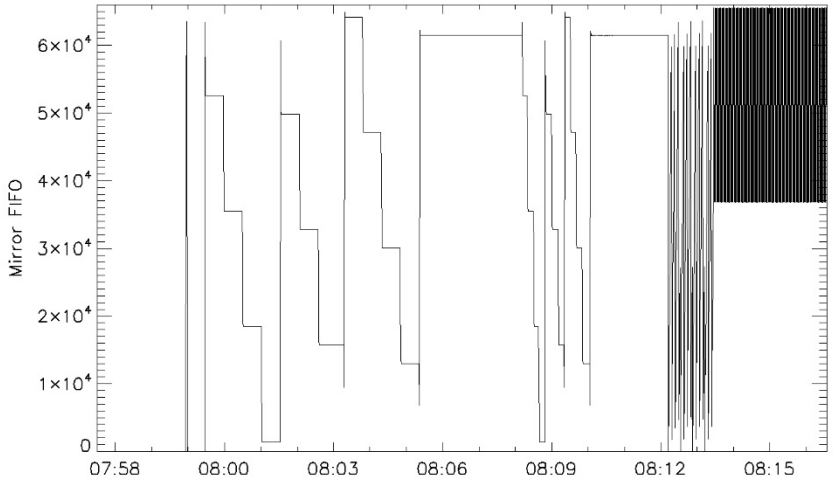
DSM fails to achieve lock when commanded to SUNBLOCK (rotation without scanning)

Commanding SAFE the drive returns to the home position.

Using position commanding unavailable in previous instruments the DSM was driven backwards for two rotations in 30º steps.

After two nominal backwards rotations lock was acquired in SUNBLOCK and nominal imaging was resumed.





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Restart – 28th June 2016

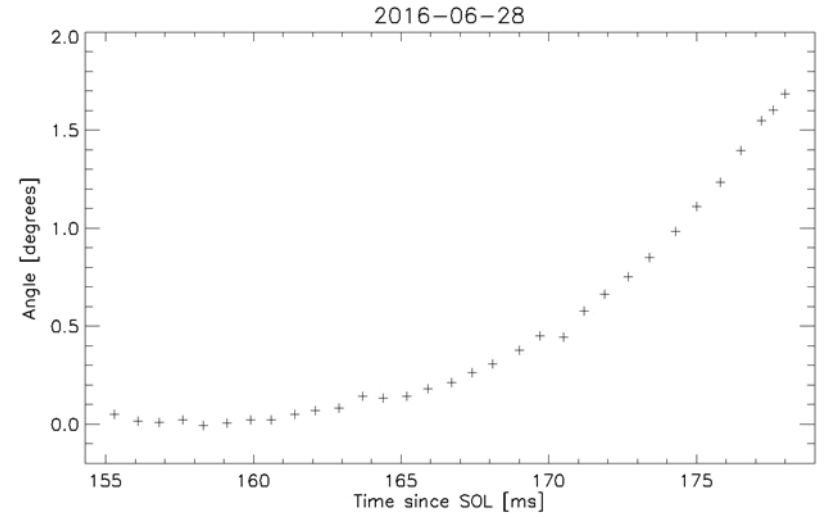
After tripping both patches the drive stops at ~277º.

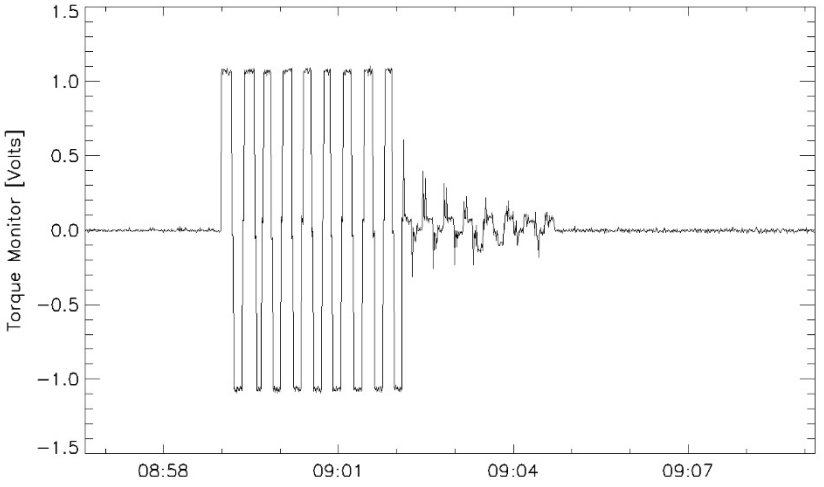
Restart attempted by backing off to 270º and commanding SUNBLOCK. Lock is not regained.

Another attempt to command the drive in the reverse rotations in 30º steps fails when the drive stops at 222º on commanding to 210º.

Commanding back and forth between 180º and 330º succeeds in freeing the drive. Nominal imaging is resumed.

Combining the two patches has thus far avoided long periods exerting maximum torque and protected against another jam.





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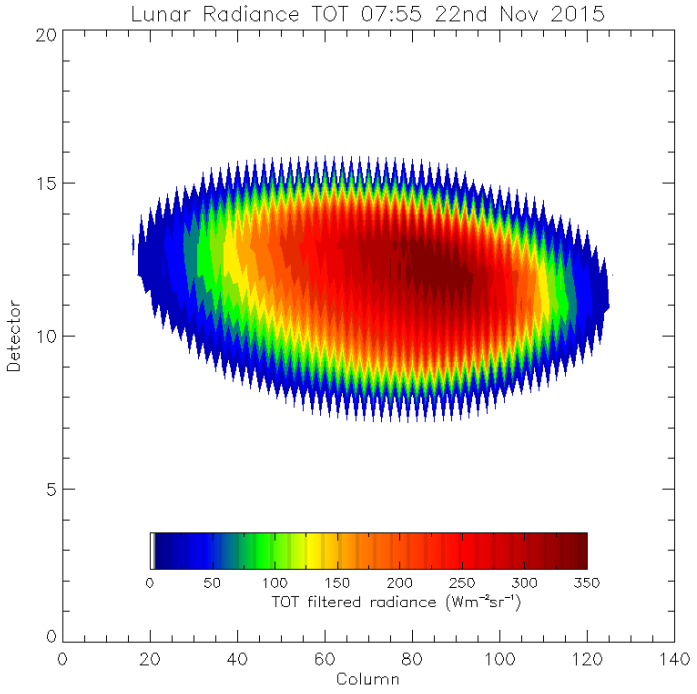
GERB-4 Commissioning Pre First IOS Storage

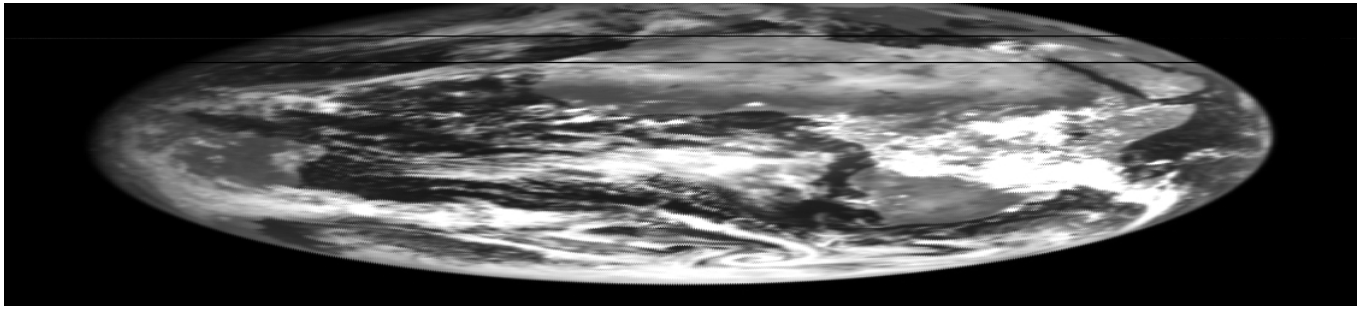
GERB-4 functional commissioning was completed on the 4th Nov 2015. The report was approved by the TRB.

Some of the calibration commissioning activities were completed:

- Lunar scans (21st-23rd Nov 2015)
- CALMON scans (9th Nov)
- Mirror Offset test (4th Nov)
- PSF limb scans (3rd Nov)
- Cross calibration (4th Nov – 6th Dec)



GERB-4 was switched off for the first IOS period on the 6th of December.



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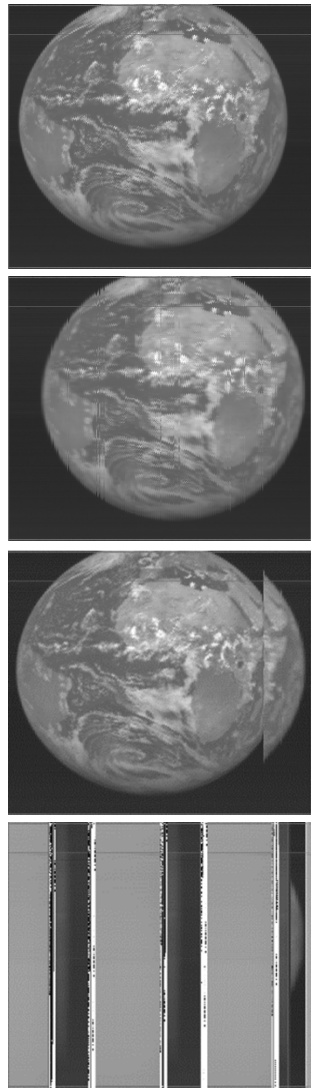
GERB-4 Early Commissioning and Spin Rate Anomaly

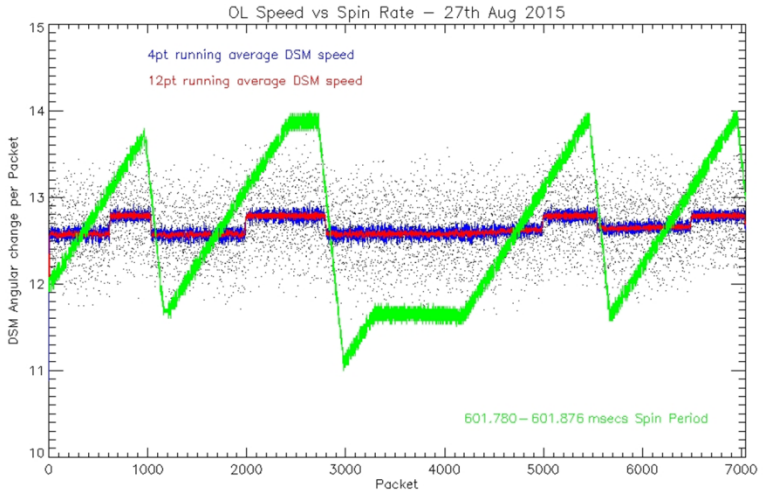
The GERB-4 Commissioning began on 6th August and during the early testing proceeded nominally.

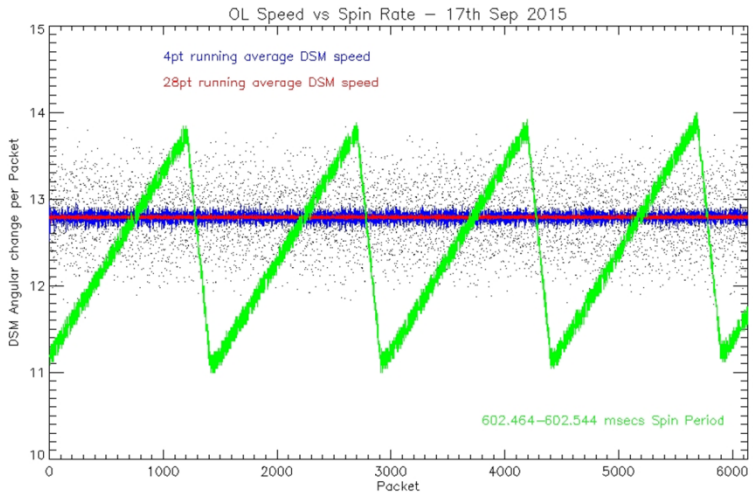
Losses of lock in SUNBLOCK were attributed to rough running of the bearing but the defects in the initial images whilst the mirror was reporting lock contradicted this.

Functional commissioning was suspended to test the anomaly.

Satellite spin rate was identified as the critical factor. Spin rate higher than 99.691 rpm have consistently triggered the problem.







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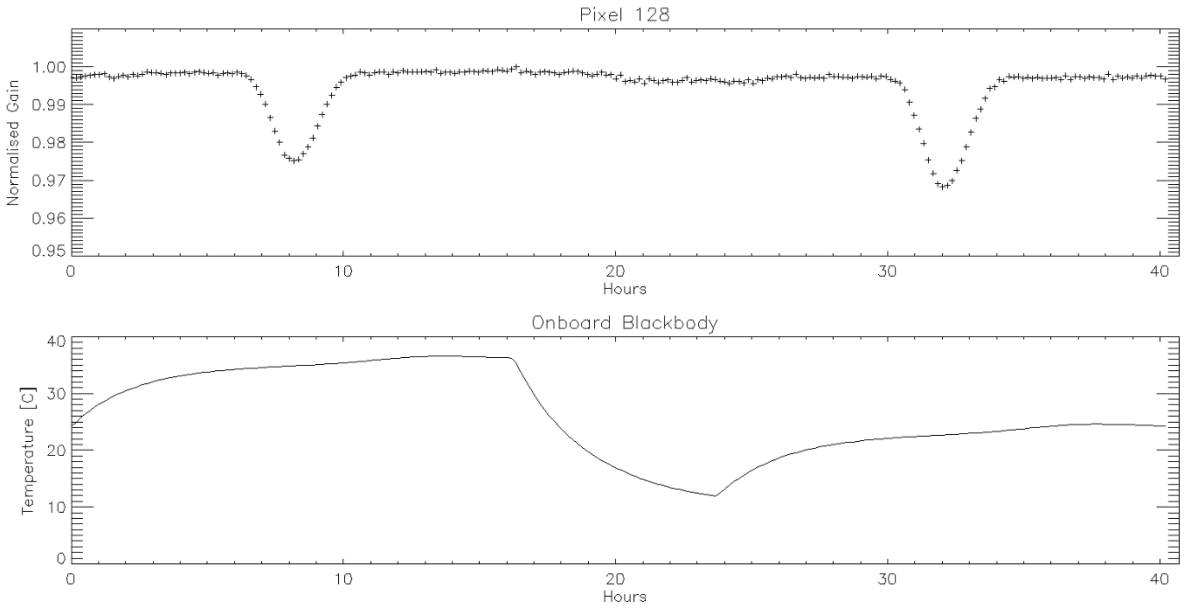
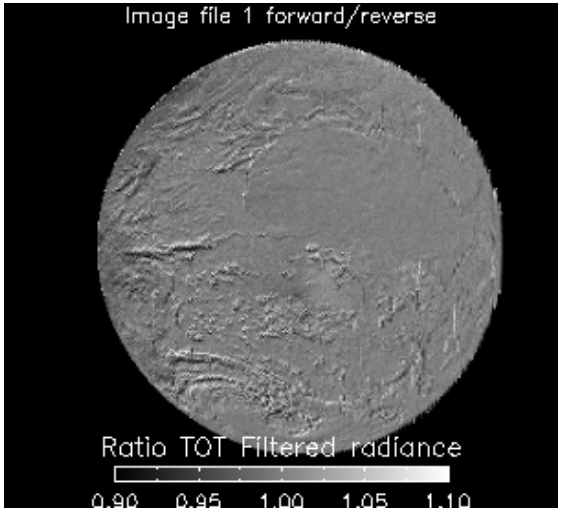
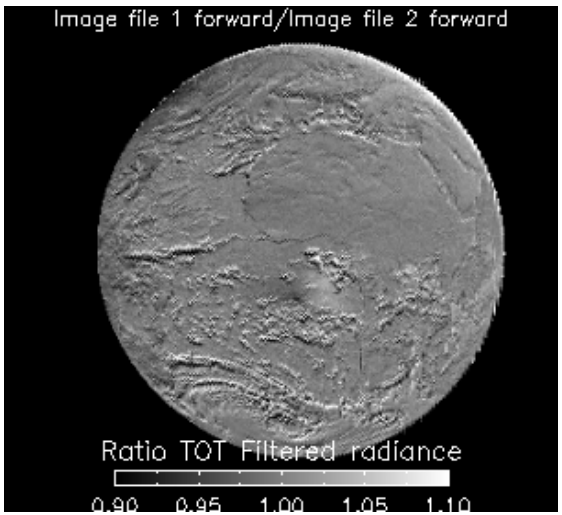
GERB-4 Commissioning During First Activation

All calibration commissioning activities have been completed as of the end of the first IOS activation:

- Deep Space scans (2nd-4th Feb 2016)
- Scan direction dependency (4th Feb)
- Nominal PSF scans (9th Feb)
- African coastline PSF scans (10th Feb)
- CALMON scans (10th Feb)







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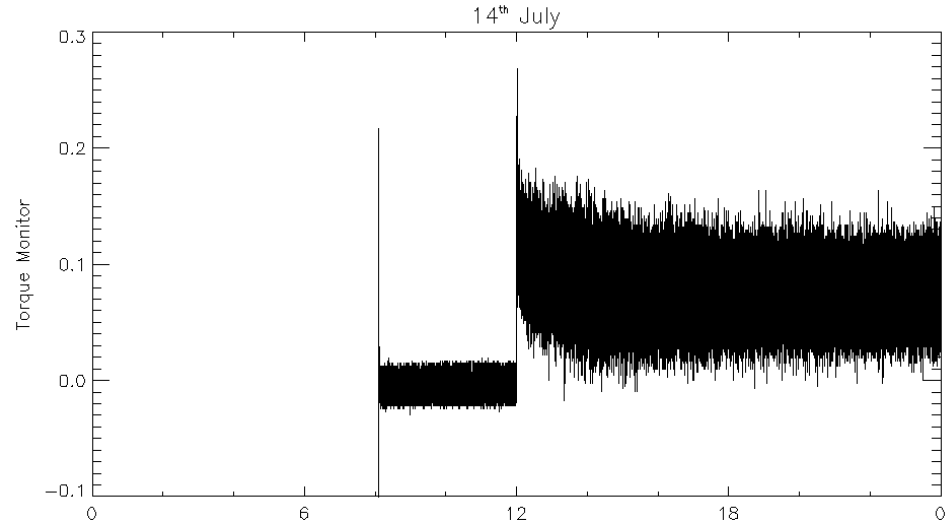
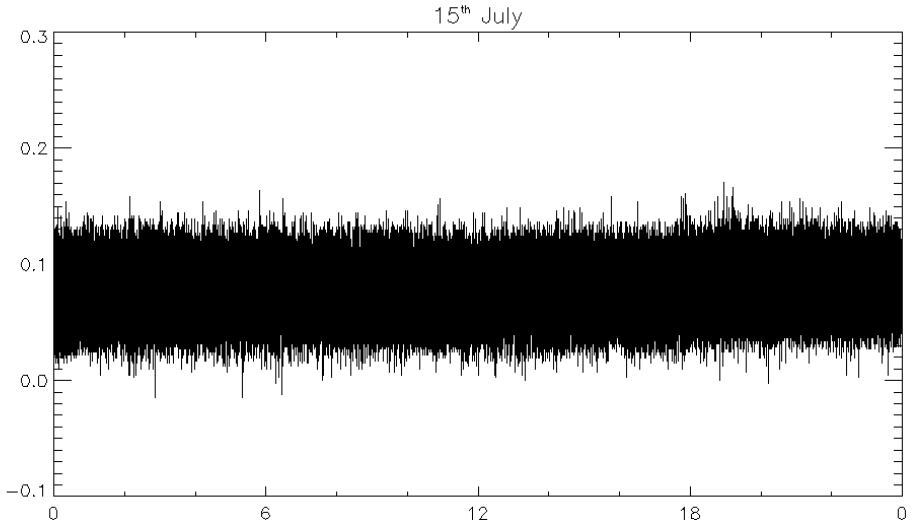
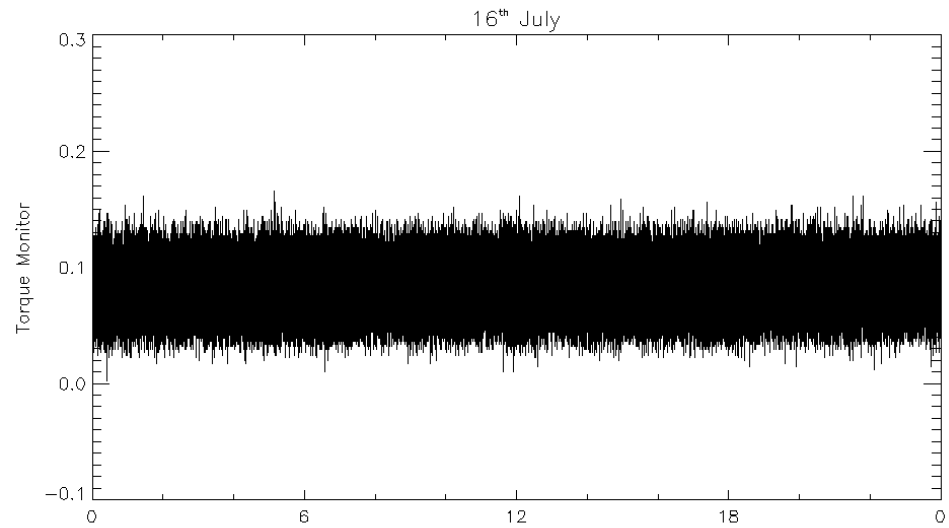
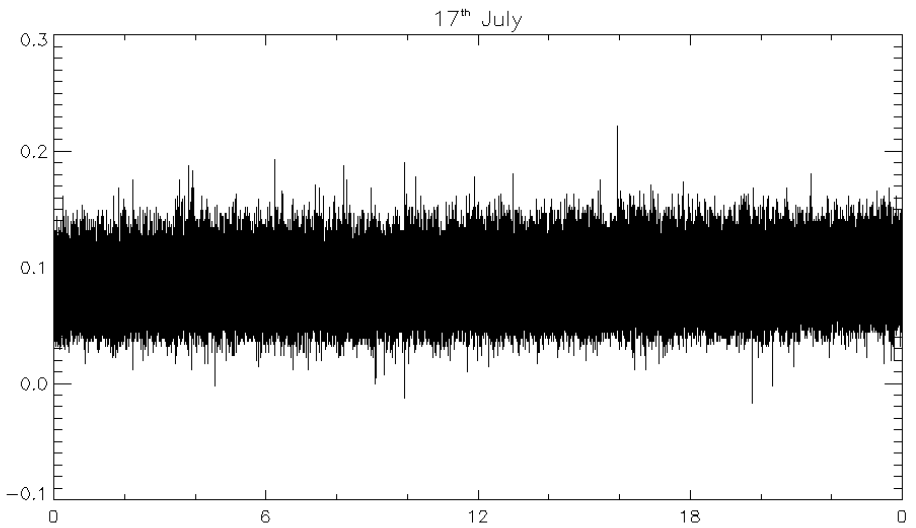
GERB-4 First Routine Activation – DSM Torque Monitor









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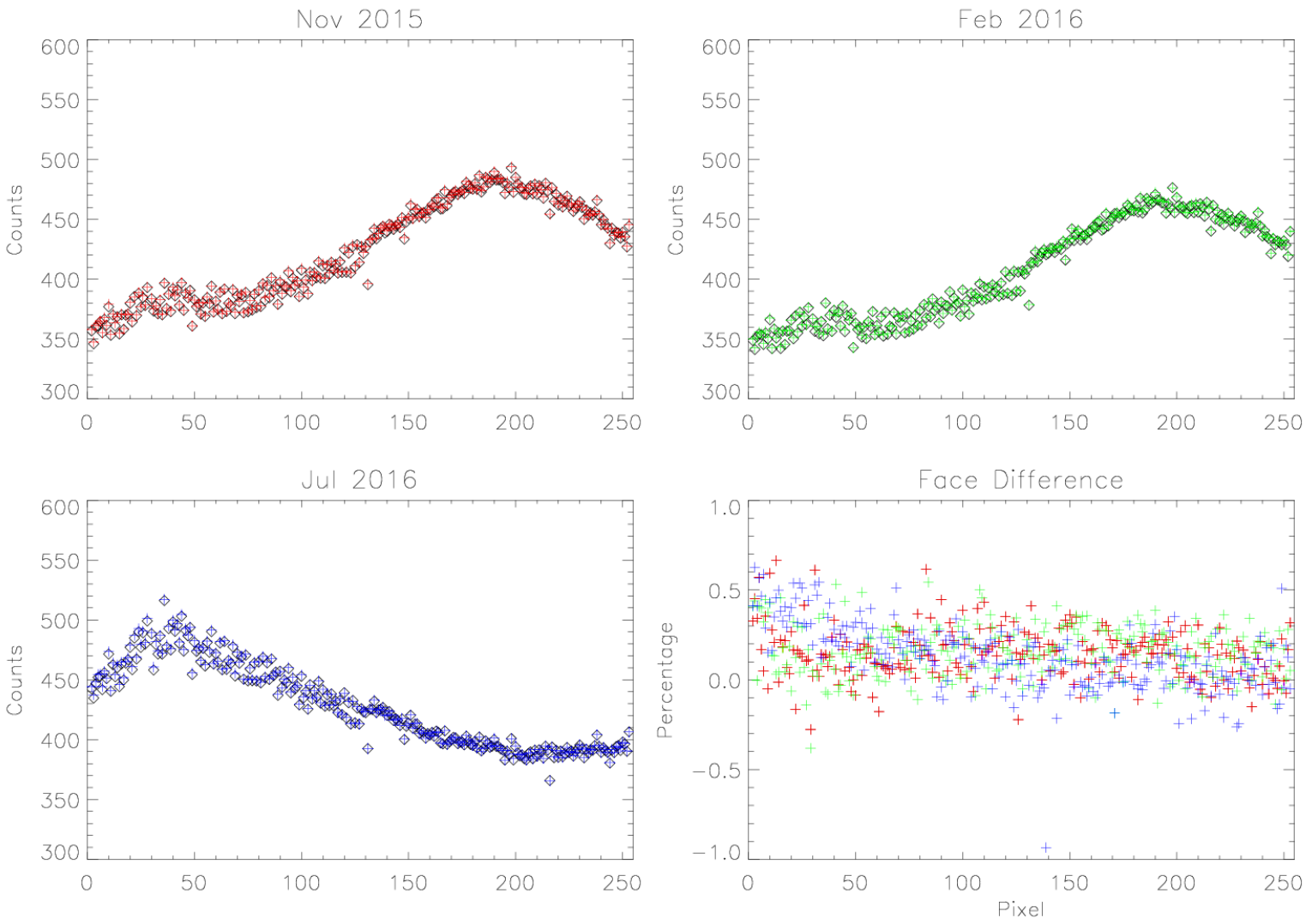
GERB-4 Activation - CALMON Mirror Face Performance



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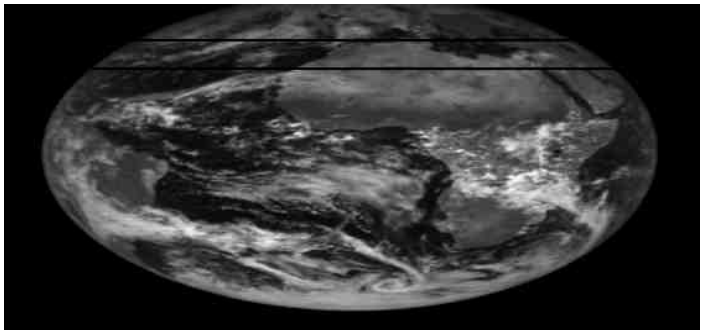
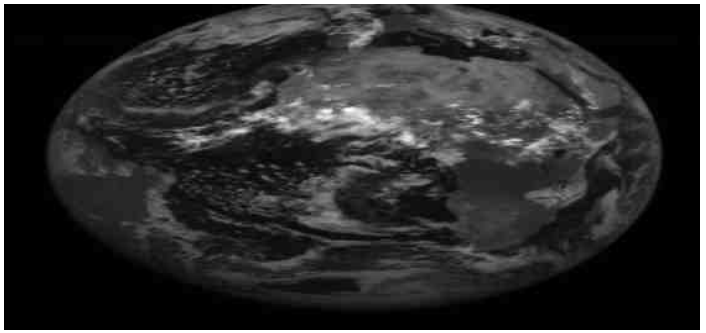
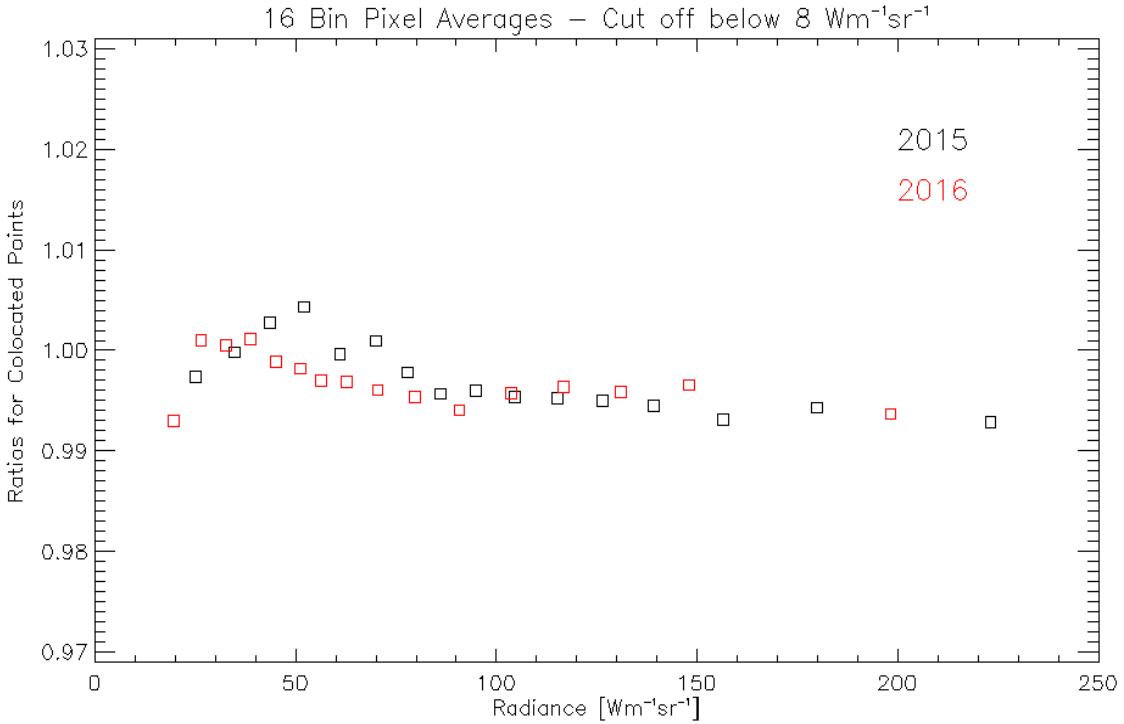
GERB-4 Activation - Earthview Mirror Face Performance







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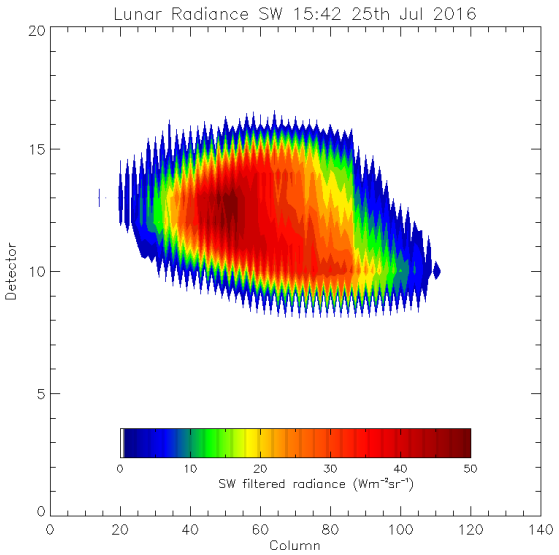
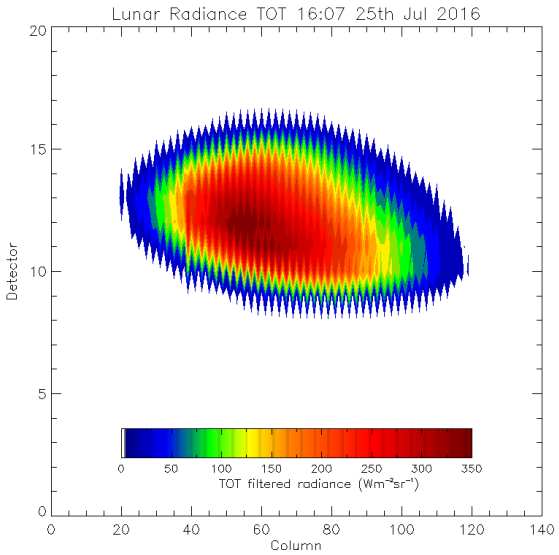
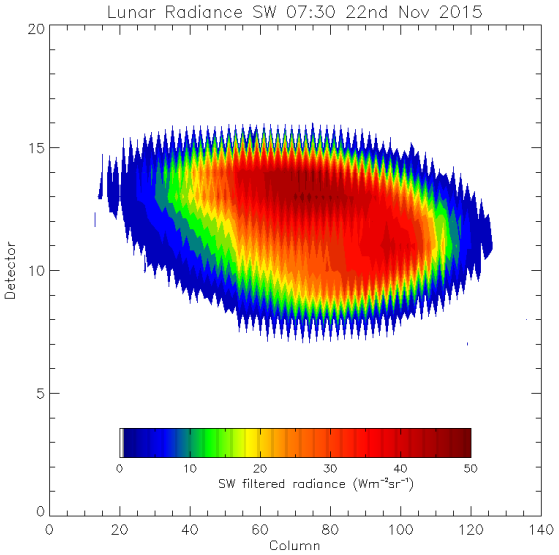
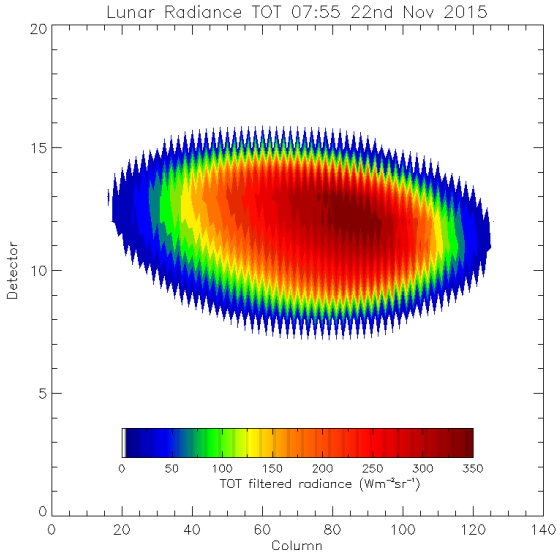
GERB-4 Activation – Lunar Scans









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GERB-4 First Routine Activation

- The GERB-4 drive bearing has shown no change in pointing performance and is still running well within specification.
- The new park position has not led to any relative change between the optical performance of the two faces
- As yet it is too early to tell whether the new park position will protect the GERB-4 despin from ageing effects as these only began to appear after 6 to 12 months on previous instruments.
- Lunar data was acquired for this GERB-4 period and should be for future activations if an observation opportunity arises.

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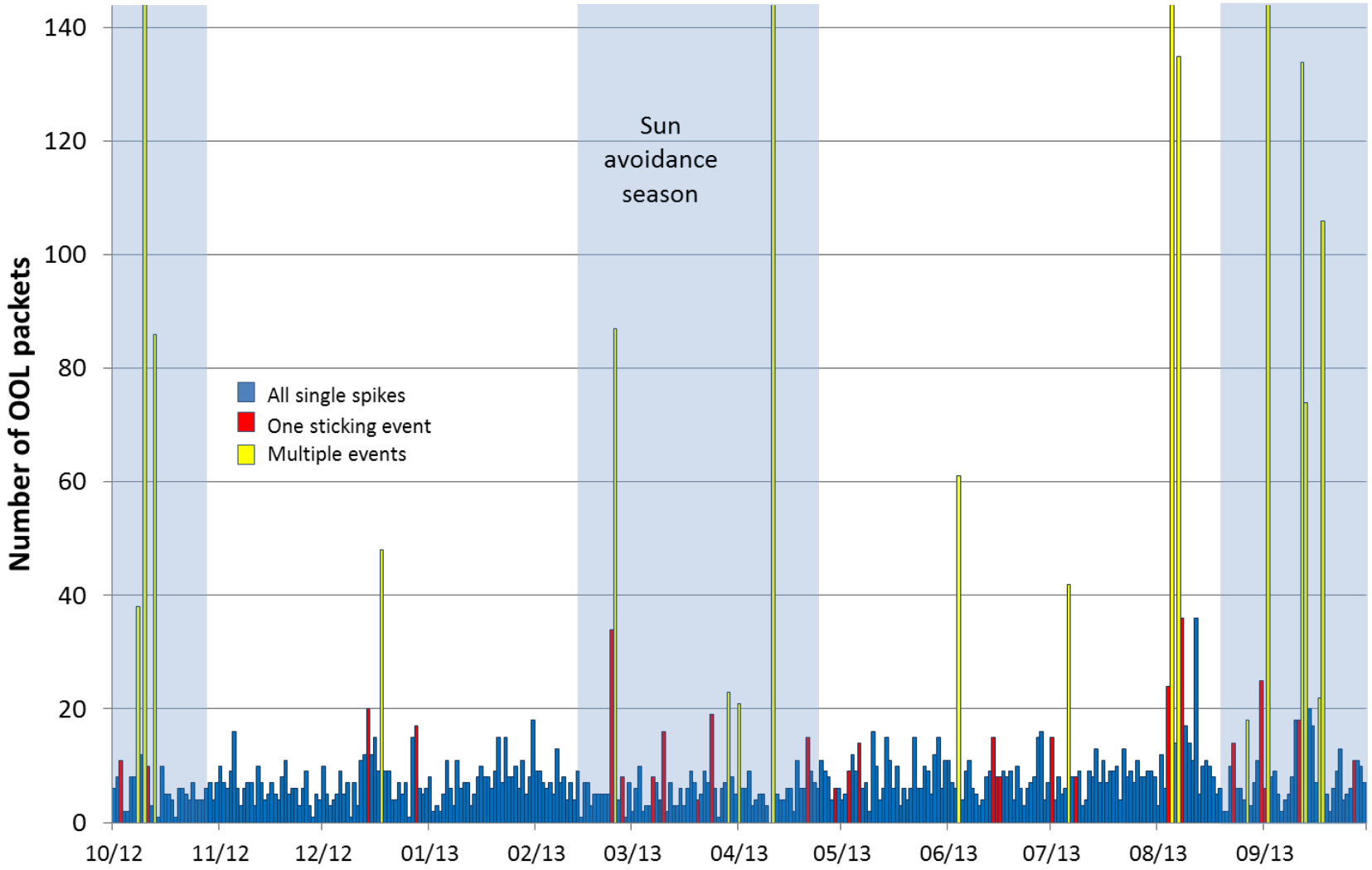
Daily GVMPERR OOL on GERB-1 Despin Mirror, 2012-13



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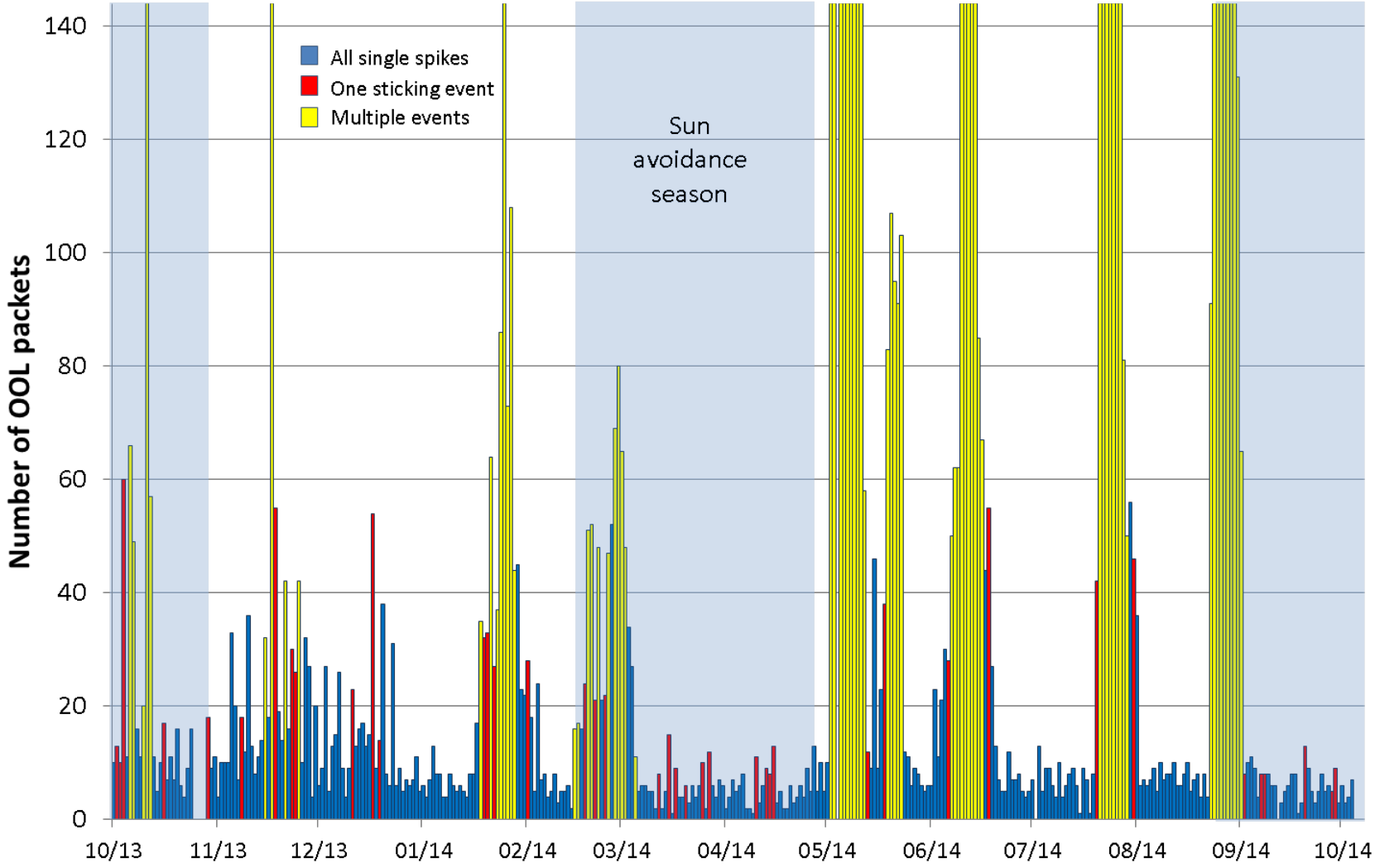
Daily GVMPERR OOL on GERB-1 Despin Mirror, 2013-14



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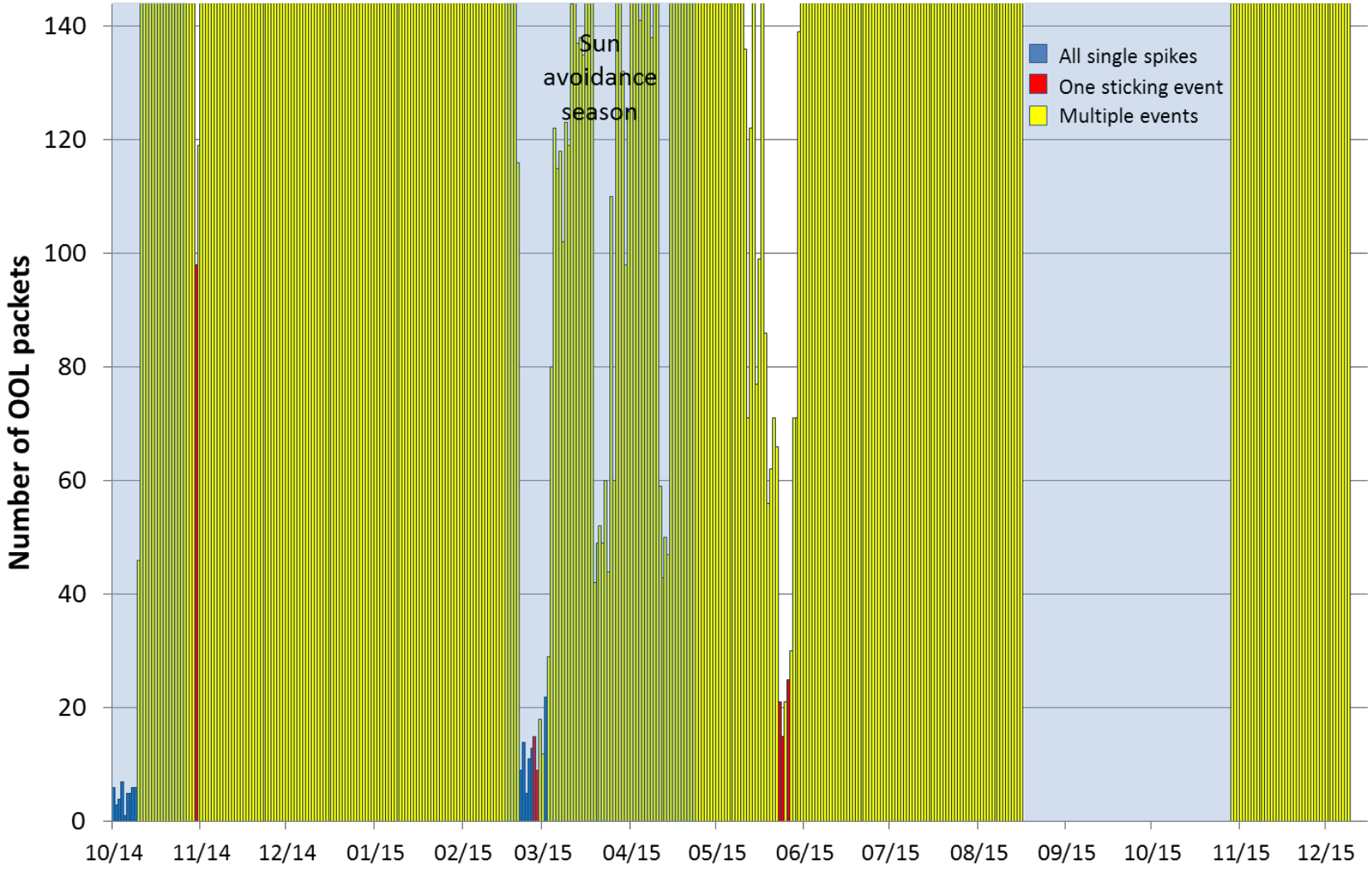
Daily GVMPERR OOL on GERB-1 Despin Mirror, 2014-15



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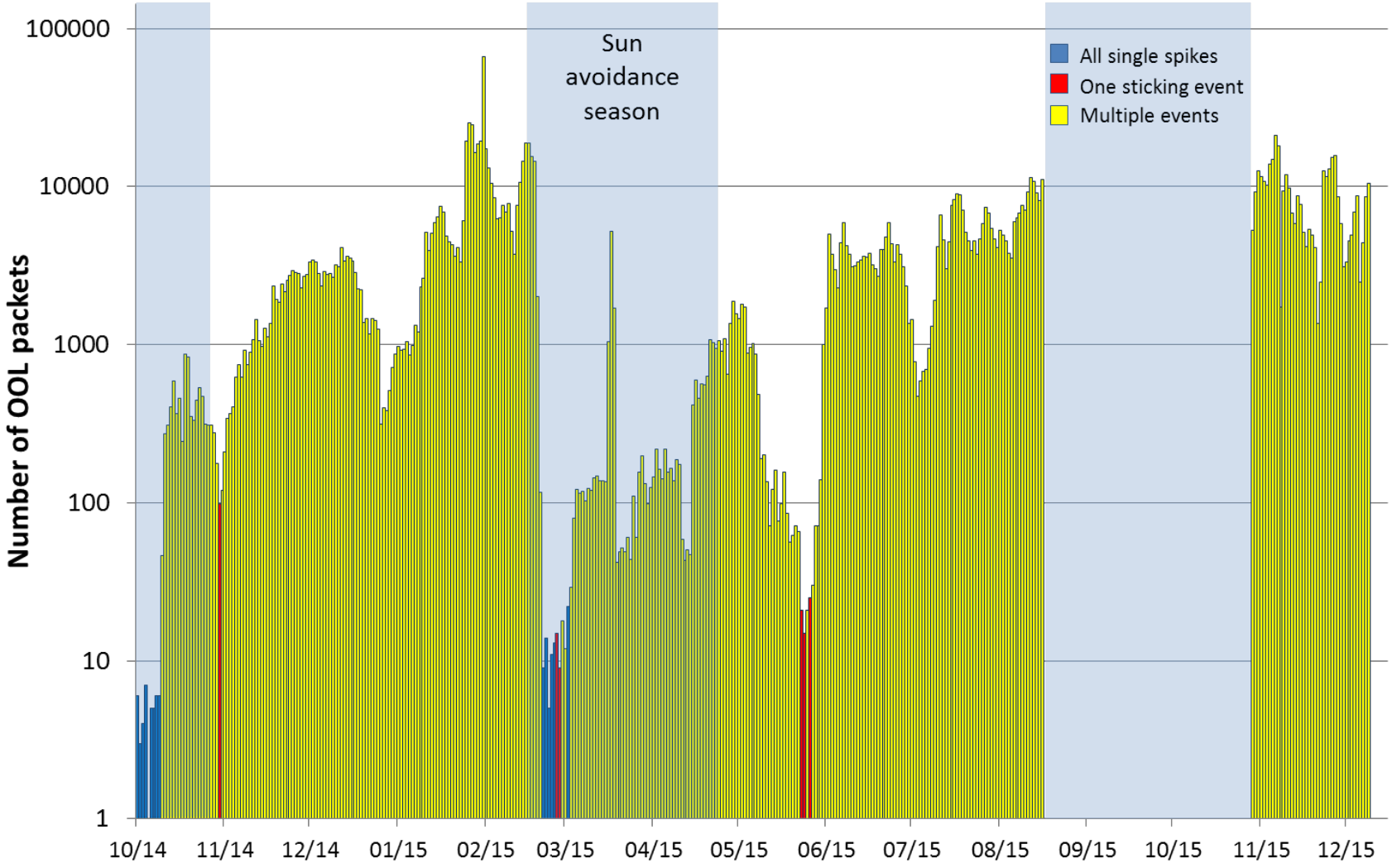
Daily GVMPERR OOL on GERB-1 Despin Mirror, 2014-15



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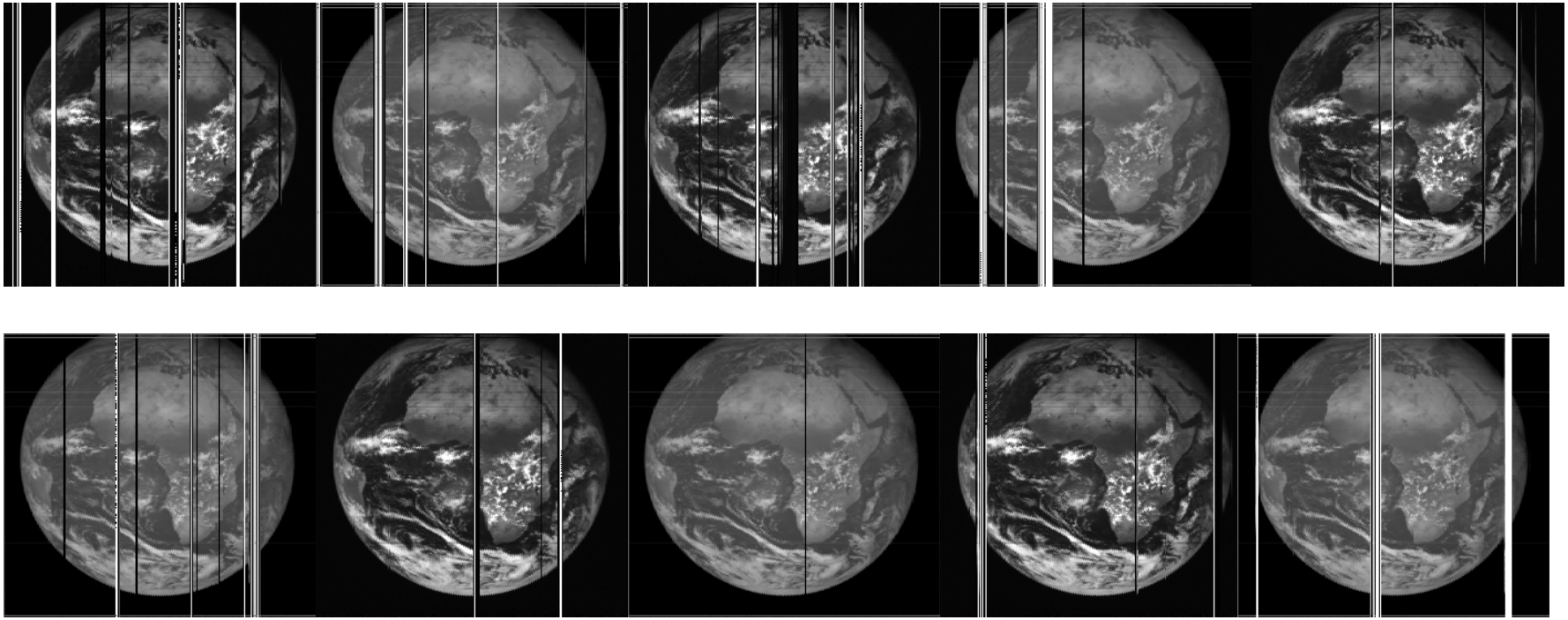
Impact on GERB-1 Images



Consecutive images taken from ~12:00 UTC on the 10th of December

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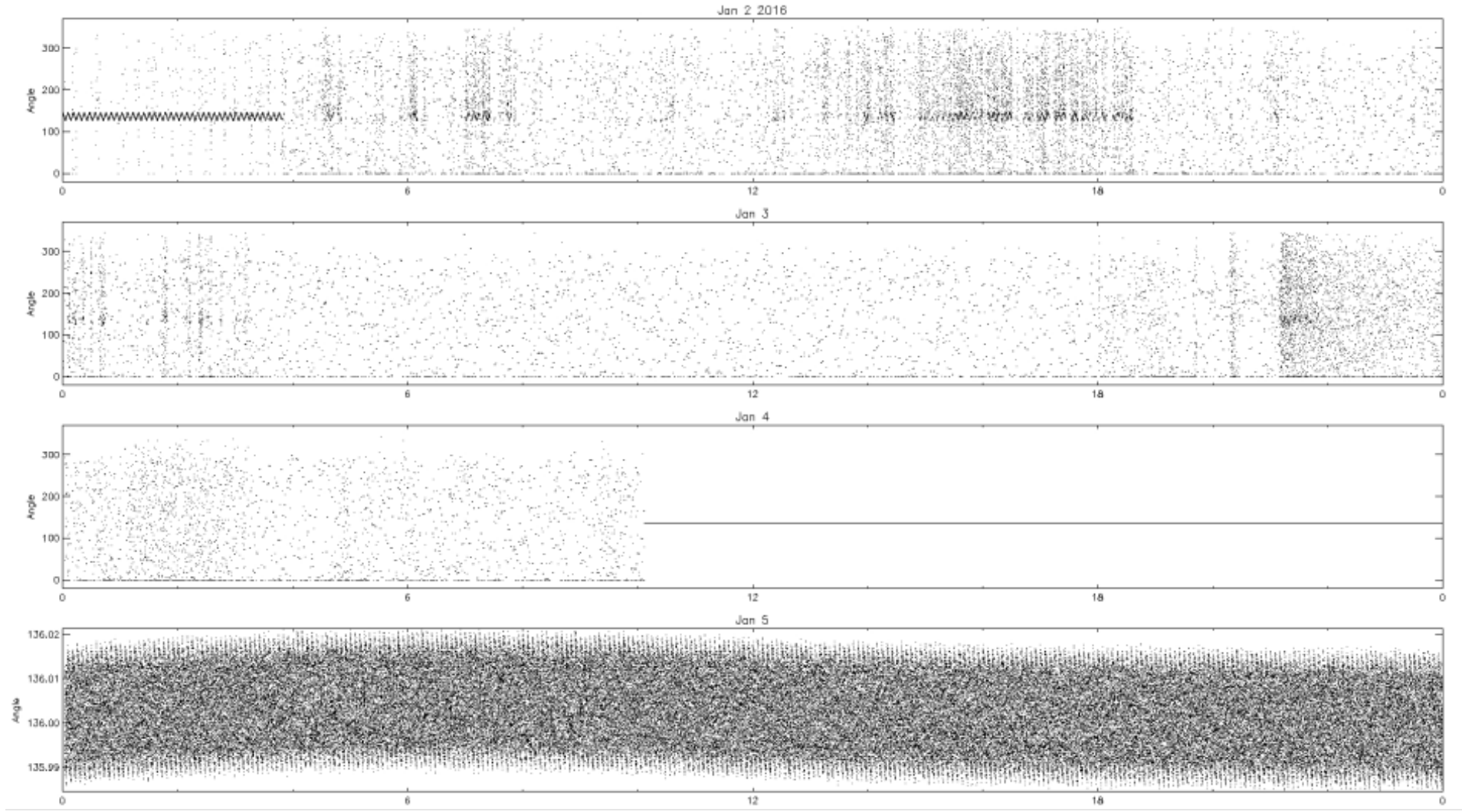
Severe GERB-1 Event : SOEP_E



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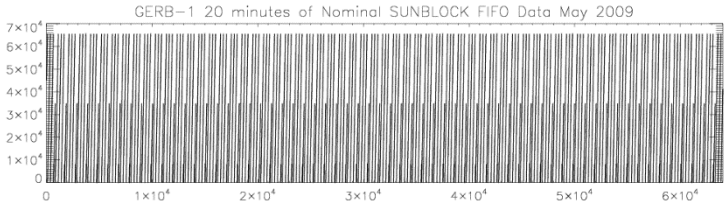
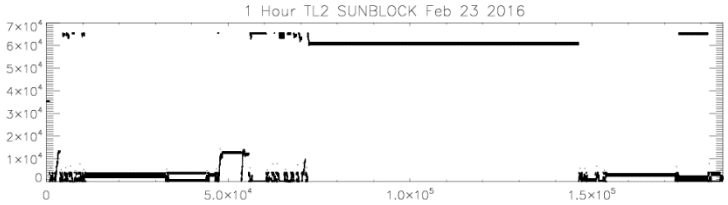
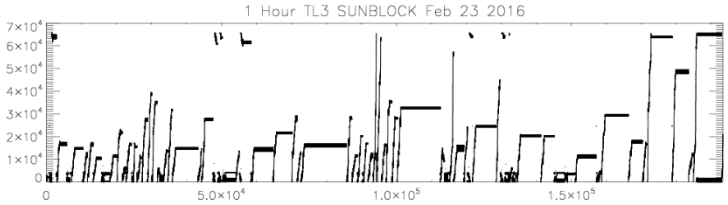
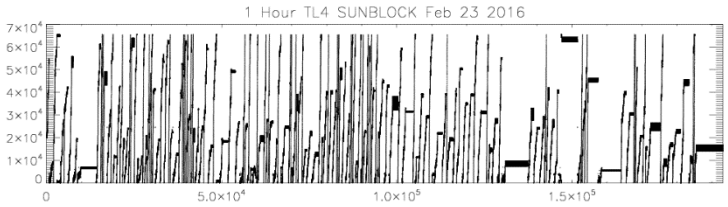
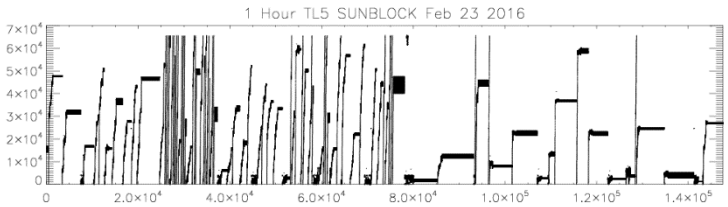
Testing Since Major GERB-1 DSM Incident – Feb '16

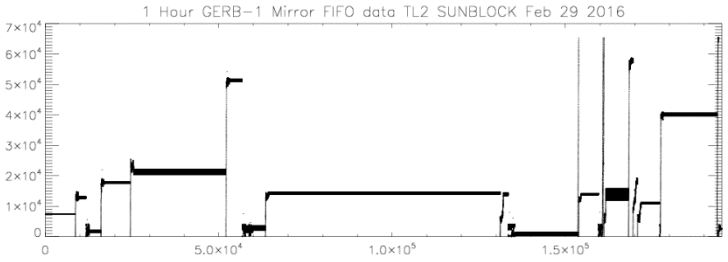


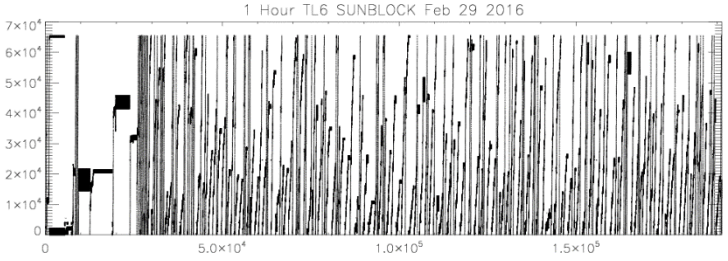


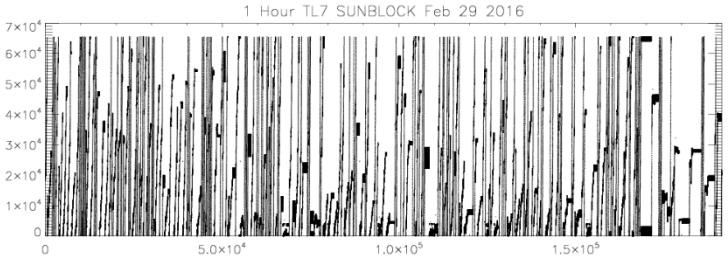


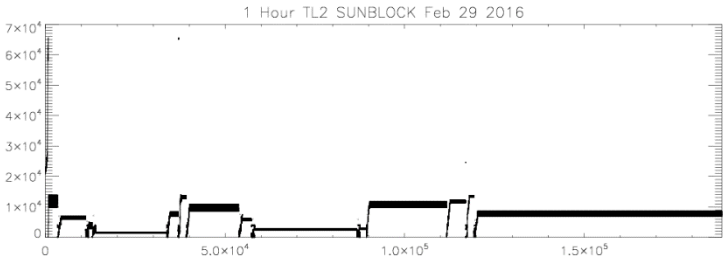












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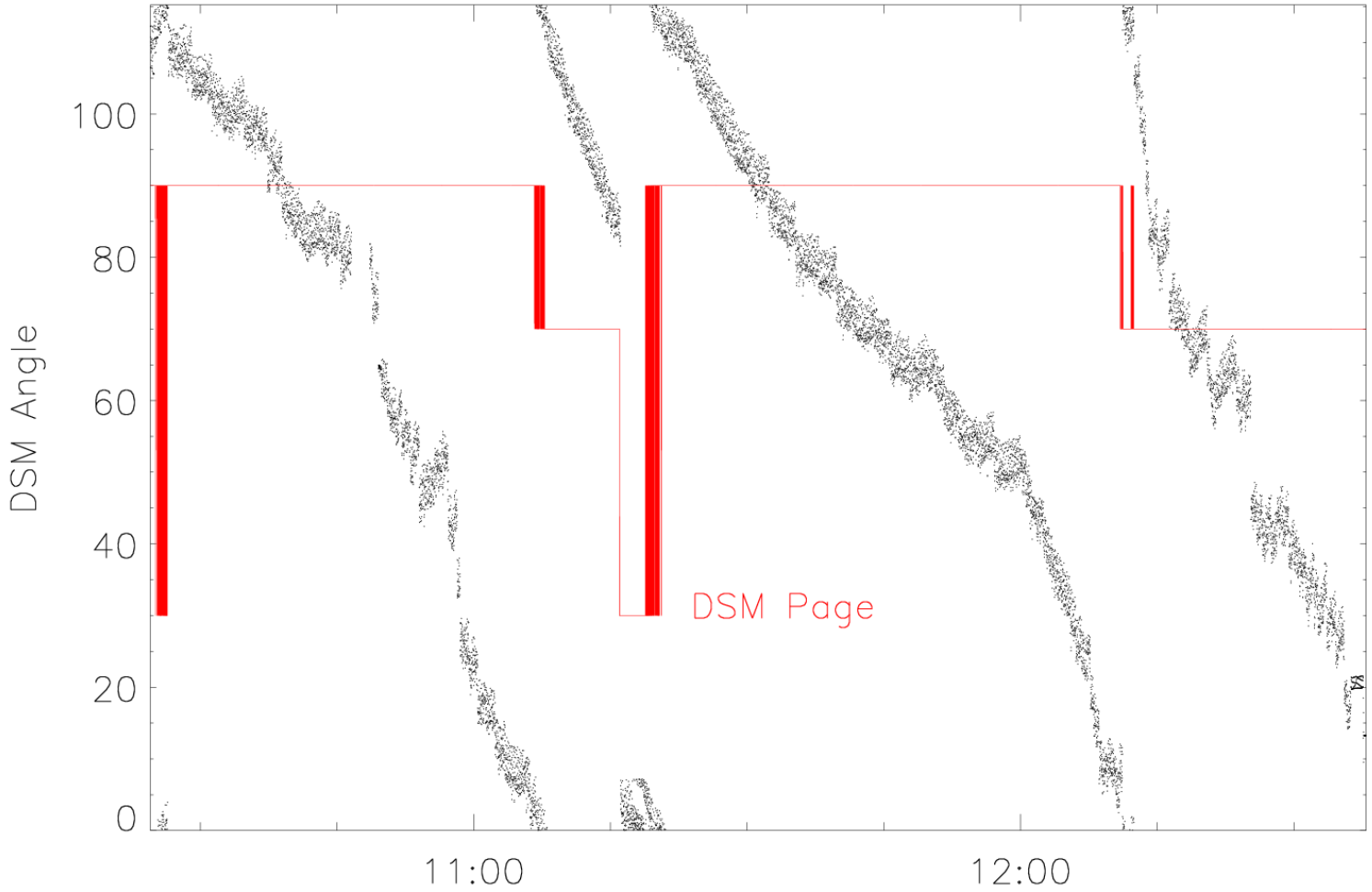
Testing GERB-1 DSM – 0x2020 FIFO Mode – 16th Aug '16



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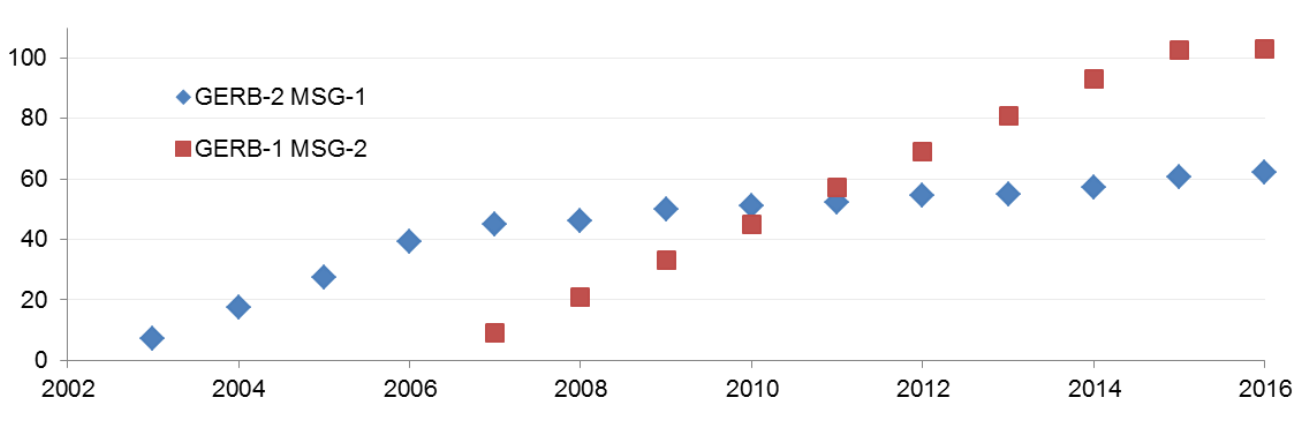
GERB-1 vs GERB-2 DSM Bearing Life

GERB-1 bearing running time exceeded that of GERB-2 during 2010.

This neglects running before launch which was also longer for GERB-1 and included an exceedance of the limit to running in air.

The performance of the bearings in orbit thus far show similar differences to the two lifetime tests. GERB-1 showing a more consistent decline while GERB-2 has recovered to low sticking levels currently.

On the ground one bearing was very rough by the end of testing and the other still performed well.



Cumulative Months of DSM running in Orbit

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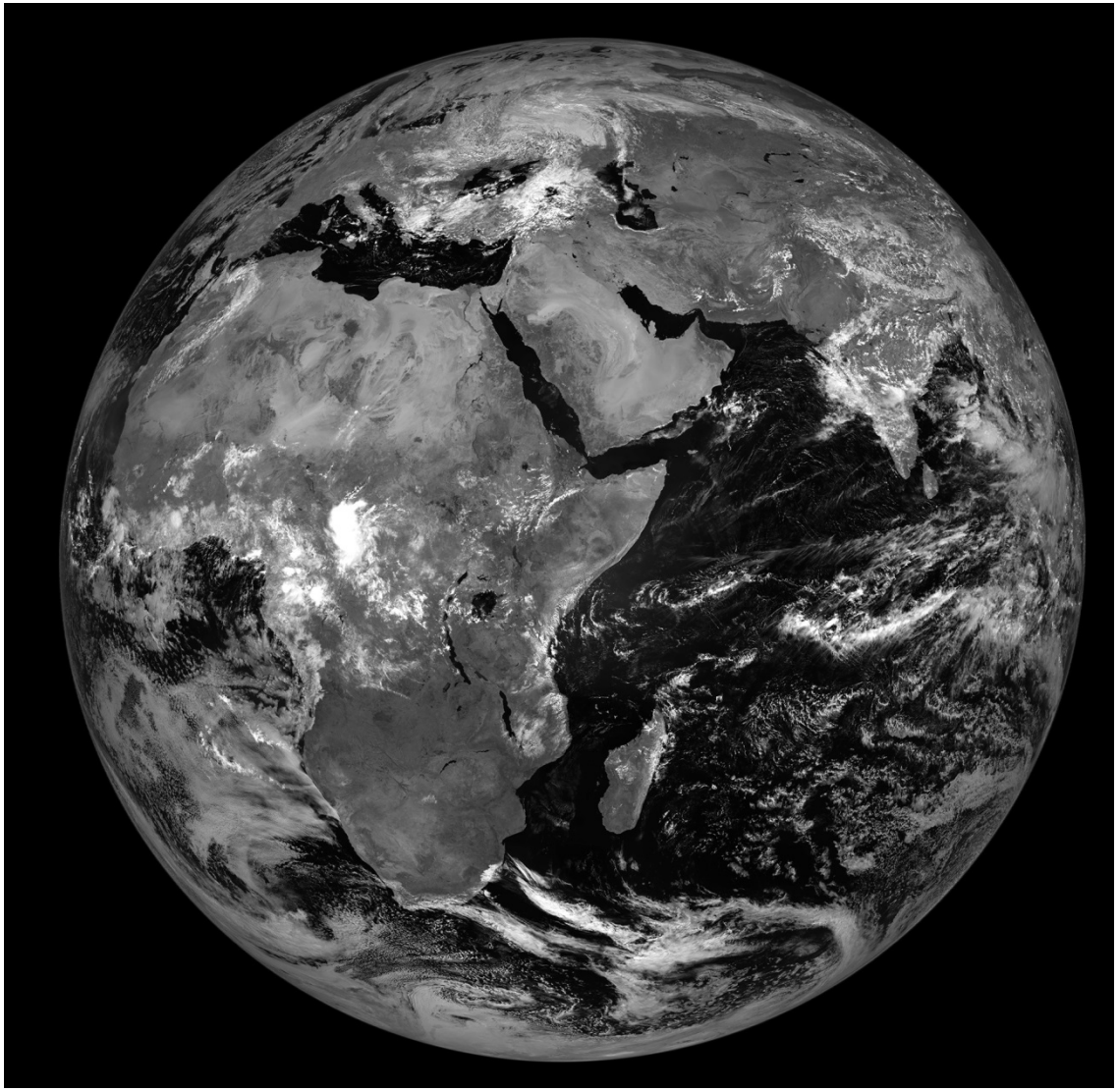
MSG-1 GERB-2 Move to 41.5ºE

In early July MSG-1 began the approximately 11 week relocation from 3.5ºE to 41.5ºE

SEVIRI on MSG-1 was imaging throughout the transition.

Drift completed on September 21st with two manoeuvres 12 hours apart.

Two month parallel observations with Meteosat-7 planned as part of the validation before MSG-1 begins IODC operational service early in 2017.



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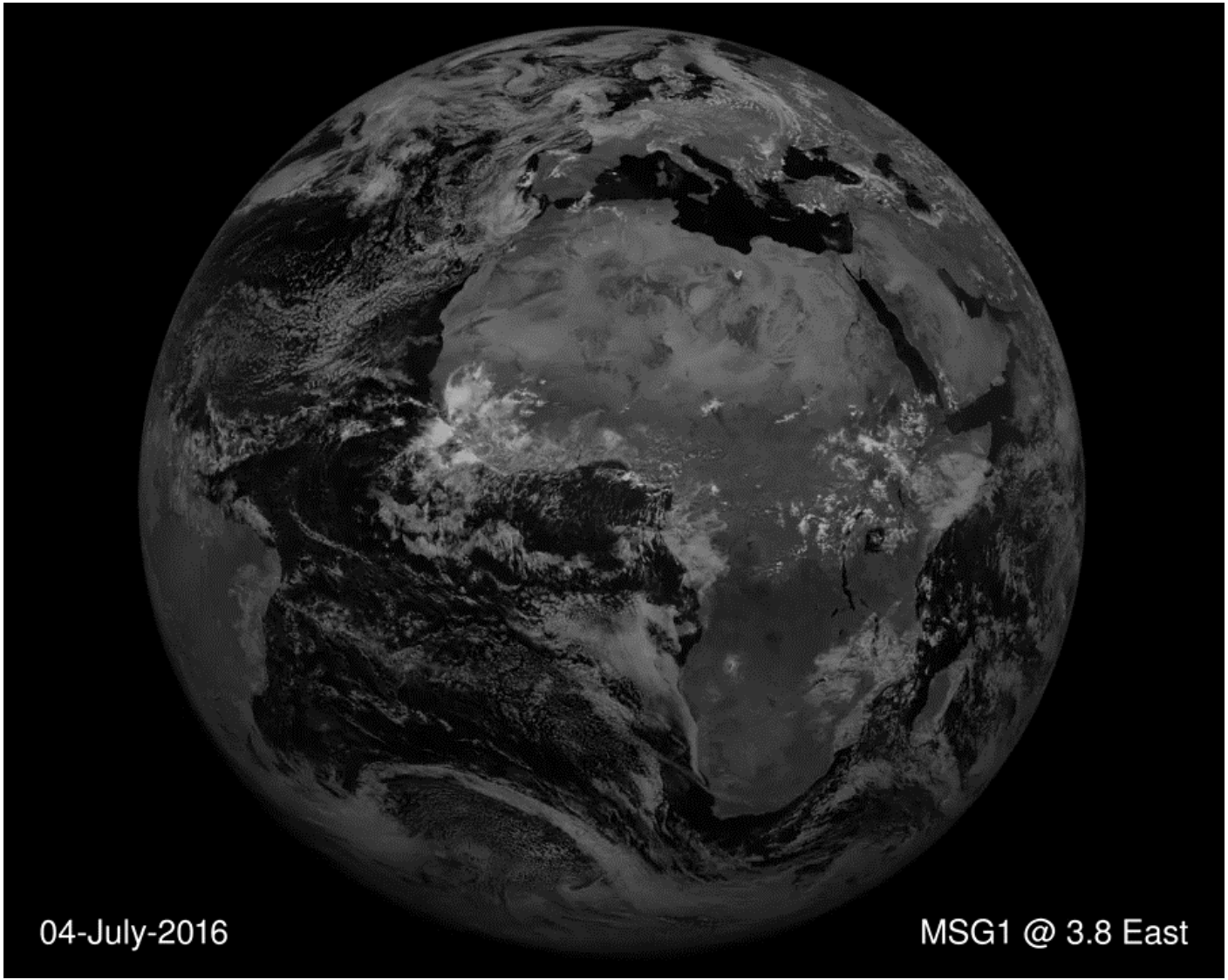
MSG-1 GERB-2 Move to 41.5°E



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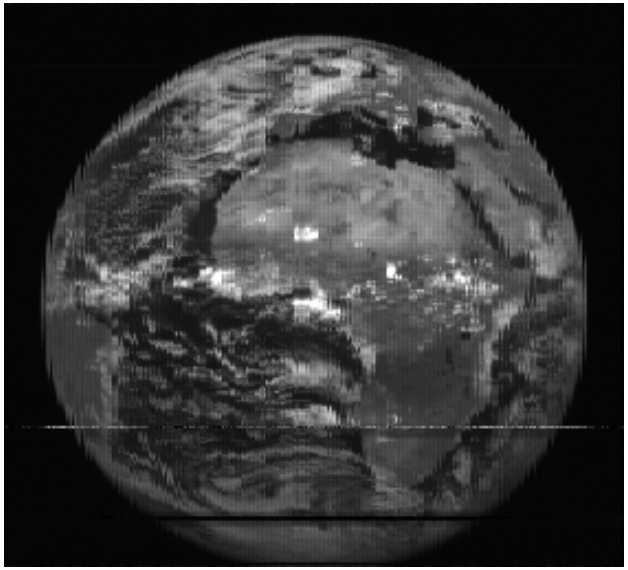
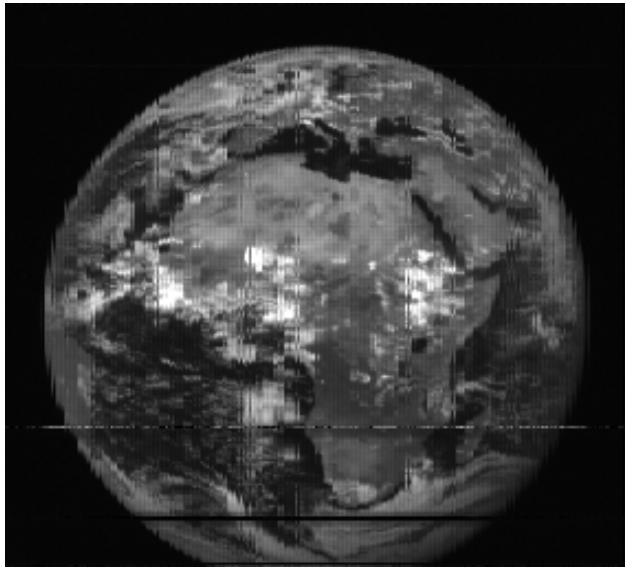
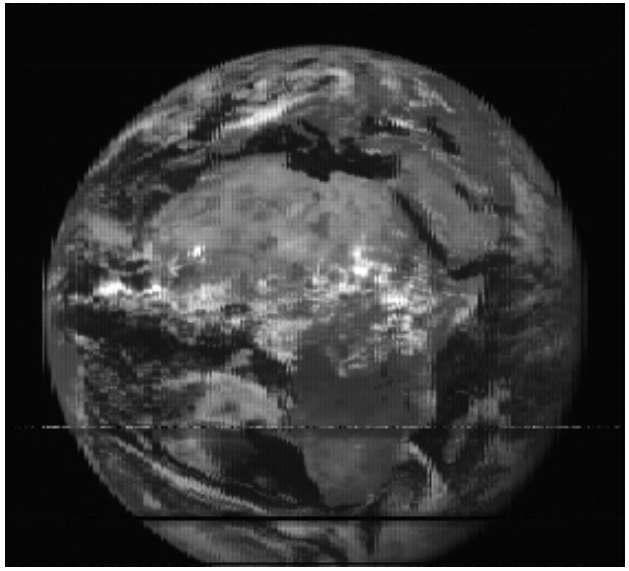
MSG-1 GERB-2 Move to 41.5ºE – GERB Images

GERB-2 Imaging during the drift:

1st July	10:30-13:30	NORMAL	3.6ºE
1st July	13:30-14:15	CALMON	3.6ºE
27th-28th Jul	9:00-12:00	NORMAL	13.8ºE
4th-5th Aug	9:00-12:00	NORMAL	17.5ºE

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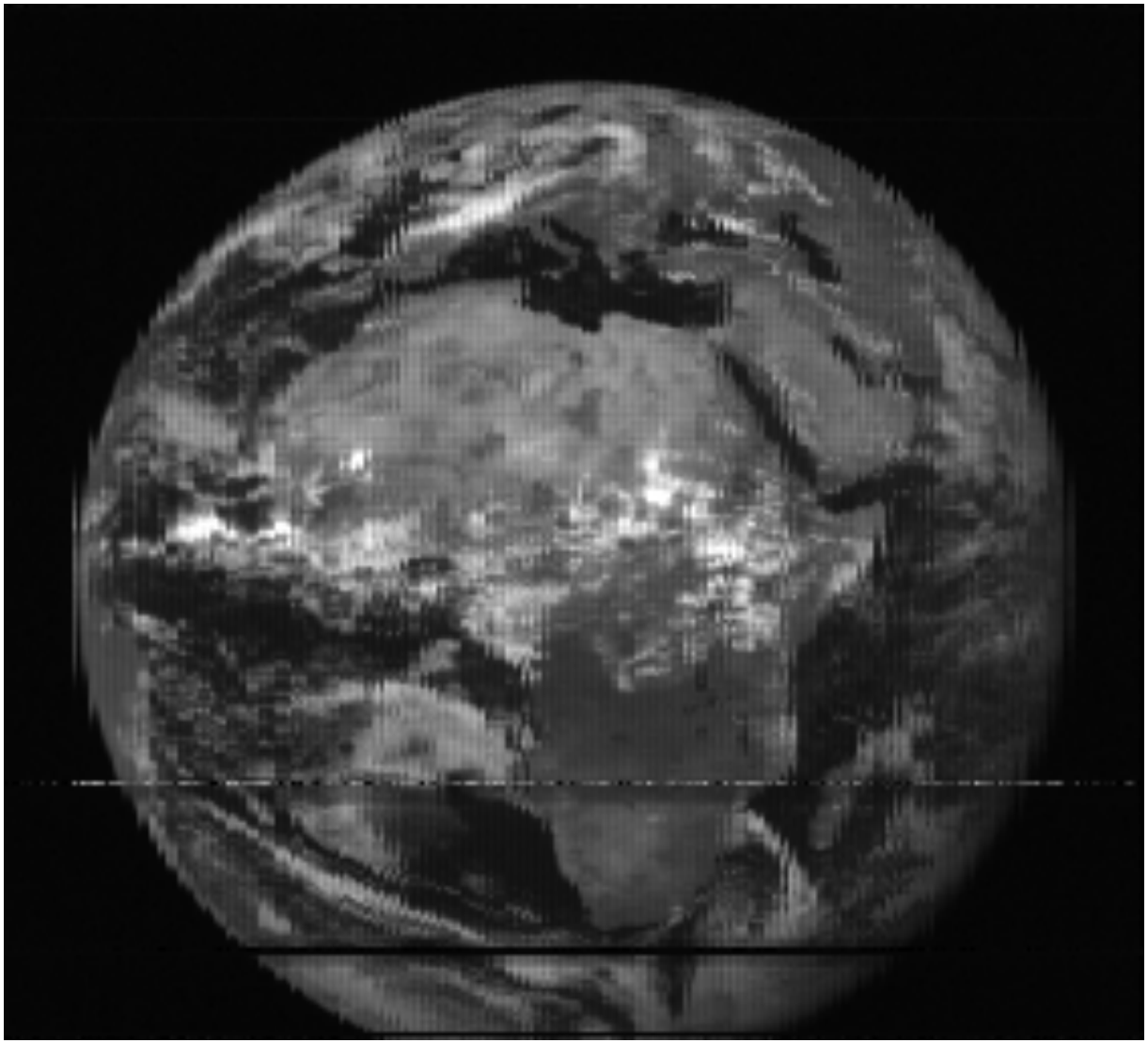
MSG-1 GERB-2 Move to 41.5°E – GERB Images on ESU



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Future

GERB-3

- Continue as prime instrument
- Investigate automation of recovery from as many mirror incidents as possible

GERB-4

- Activation sequence
  - Jan/Feb 2017 MSG-4 payload activation
  - July/Aug 2017 MSG-4 payload activation (SEVIRI?)
  - Jan/Feb 2018 MSG-4 possibly brought out of storage

GERB-1

- Final part of DSM testing is to execute GSMWELLY command
- Short burst of boost to maximum nominal torque

GERB-2

- Return to imaging on the 26th October (on SSU)